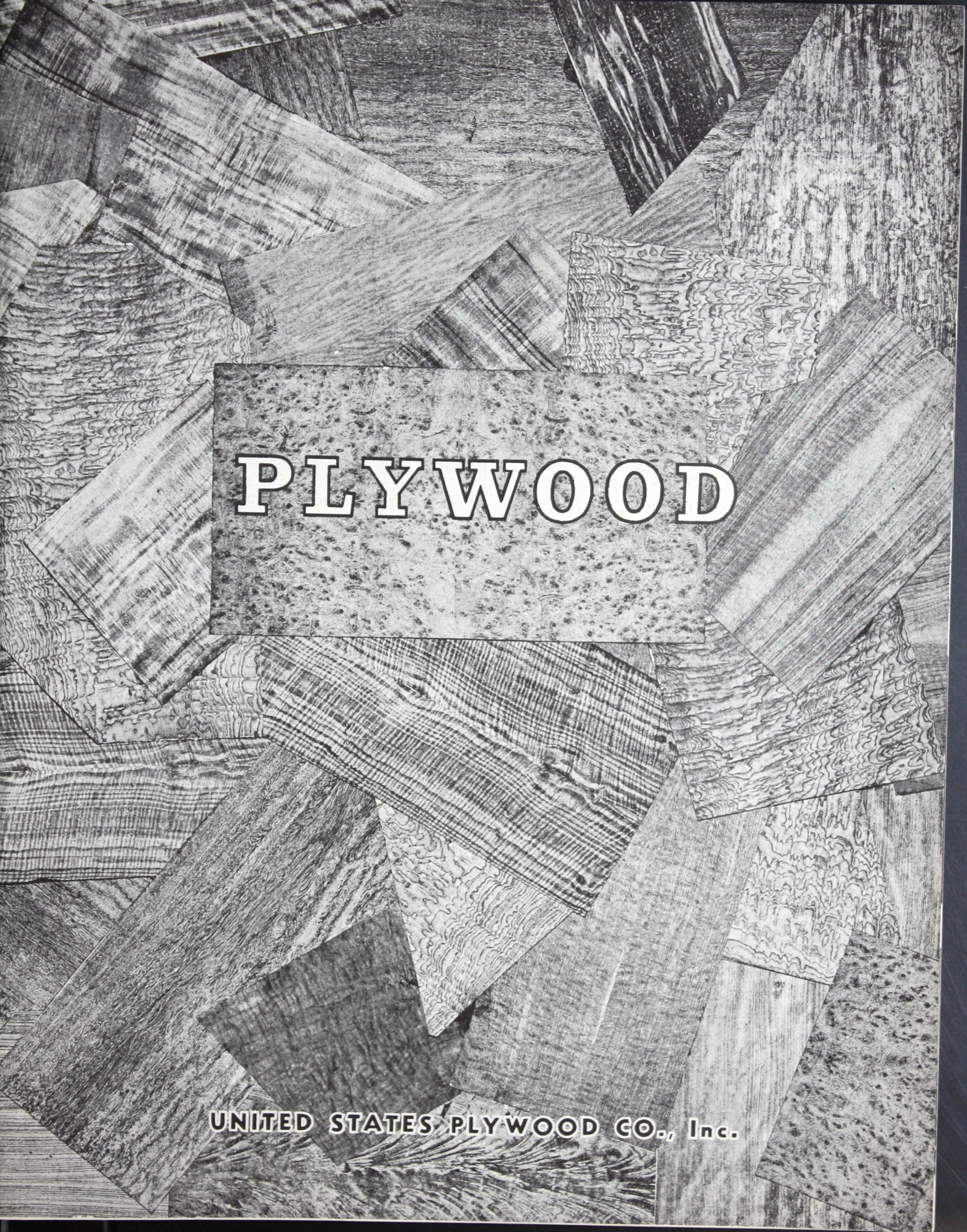
PLYWOOD
UNITED STATES PLYWOOD CO., Inc.

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We greatly appreciate the cooperation of the following in providing us with some of the data contained in this book:

U. S. Forest Products Laboratory
American Walnut Manufacturers' Asso.
Homefurnishing Arts
American Architect
Mahogany Association
Behr-Manning Corp.

The following illustrated and priced catalogs are obtainable on request:

CATALOGS

GENERAL PLYWOOD CATALOG

FLEXWOOD ARMORPLY MICARTA

UNITED STATES PLYWOOD COMPANY

INCORPORATED

FD 89-1679 JCT

(c.1930-40)

EXHIBIT FILE
FRANKLIN INSTITUTE

FOREWORD

SINCE NO HOME, however modest, is without some product made of Plywood, it is surprising to find so many who have never heard of it. Some, though generally familiar with Plywood, do not realize its infinite variety, physical properties, availability or cost.

We are attempting herein to present our subject so as to inform the artisan about the product from its commercial side (the kinds, sizes and thicknesses available from stock) and to provide the architect and the engineer with technical data not generally available. While the basic principle of Plywood is easily understood, it is a large and complex subject which we have attempted to present and illustrate briefly and simply.

THE PHYSICAL PROPERTIES OF PLYWOOD

WOOD is a non-homogeneous material. All of its weaknesses lie across the grain. Expansion and contraction under heat and moisture and the attendant defects, such as warping and checking, are due to cross-grain structural weakness. Wood has great strength and practically no movement the long way of the grain. To counteract these inequalities in the physical properties of wood, Plywood was developed many years ago.

Plywood is the term used to describe a combination of several plies of wood glued together so that the grain of any one ply is at right angles to the adjacent ply. By balancing such construction, a product of great strength results, uniform in all directions, minimized in movement and providing a sound base for fragile figured veneers. Thus the inherent defects of wood are corrected and the resultant product presents large well-behaved flat or curved surfaces. Giant strides have been made in the technique of Plywood manufacture in recent years.

The Steinway piano, the Victor radio and phonograph, the Philco radio and all high-class furniture and woodwork employ Plywood exclusively for all wide surfaces. Properly manufactured, it never fails.

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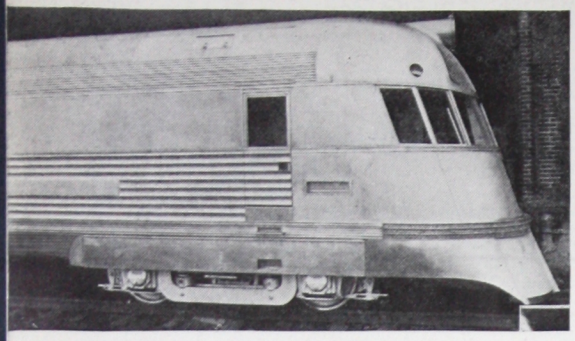
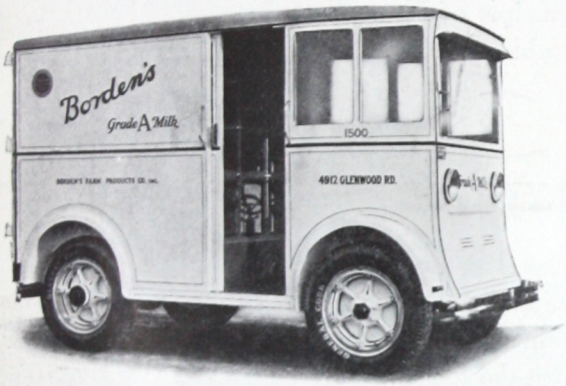


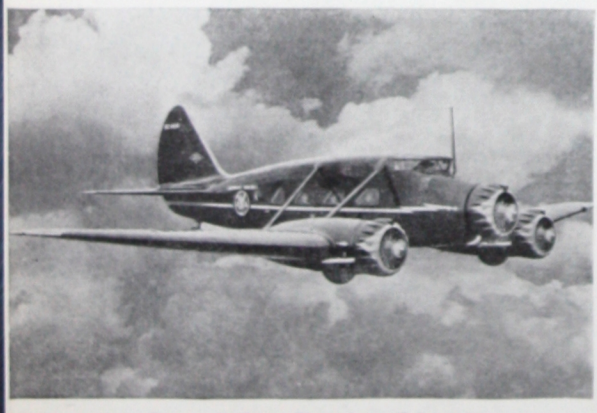
Armorply deadlight panels on Burlington Zephyr.

Yacht "Grey Gull" used Plywood panelled interiors.



Armorply used for side panels in Borden's trucks.

Airflow Chrysler uses Fir Plywood for floor boards.



Stinson Air Liner. Plywood panelled interior.

THE USES OF PL

The uses of Plywood run the gamut from baby carriages to automobiles, from toy boats to giant ocean liners, and from the farmer's utilitarian homestead to the finest hotels and apartment houses. In our roster of accounts will be found hundreds of names of outstanding concerns of the country employing plywood in a hundred different ways either for its structural qualities, its beauty or both.

A unique and important branch of our service is the manufacture of Plywood to meet engineering specifications. An example is found in the sensational streamline trains, the Burlington "Zephyrs," where ARMORPLY,* metal-covered Plywood, was used for the upper outside panels. These panels are specially constructed Armorply made with a face of thin stainless steel and backed with extremely thin electrolytic copper. The edges of the steel are turned and soldered to the back so as to hermetically seal the three-ply Basswood core panel. A similar construction has been employed on new cars of the B.M.T. subway and the Boston & Maine streamlined "Flying Yankee." The Edward G. Budd Com-

* *Trade Mark Registered.*

OF PLYWOOD

pany of Philadelphia is the manufacturer of all of these trains.

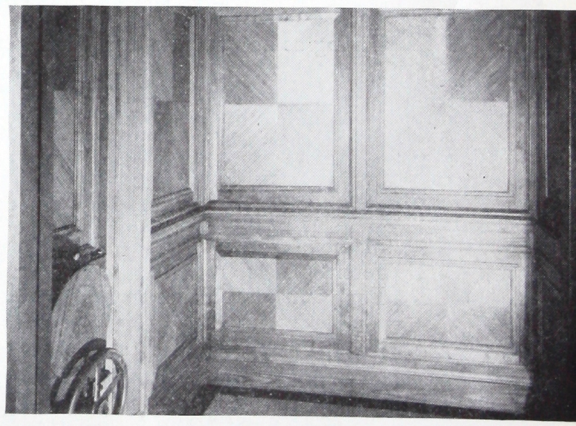
Many of the finest aeroplanes employ United States Plywood Company products. For aeroplane construction, specially glued Birch and Mahogany panels and also panels faced with very thin duralumin, applied with our patented elastic glue, are manufactured. Other products used on aeroplane interiors for decorative purposes are Flexwood and Micarta.

Automobile manufacturers find Plywood the ideal material for floor boards. Not alone has it the strength to carry necessary weight, but it also has a high insulating value, keeping out cold in winter and heat in summer.

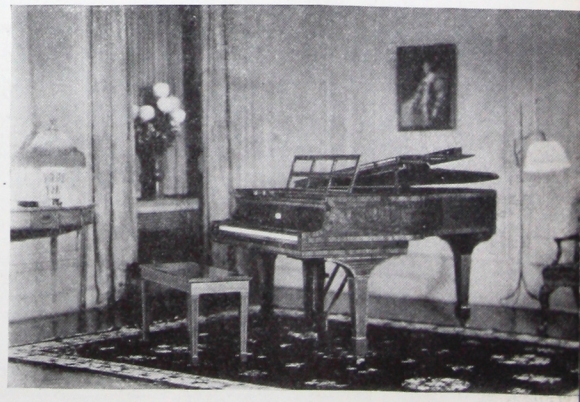
Installations in office buildings, hotels, restaurants, elevator cabs and theatres show that Plywood as panelling may be used to beautify in a way which is not possible with any other material. Architects have, in our products, an inexhaustible field for use in modernization and new construction.

Living room panelled in Knotty Pine Plywood.

Schwarz's Restaurant, New York. Walnut Plywood bar and Walnut panelling.

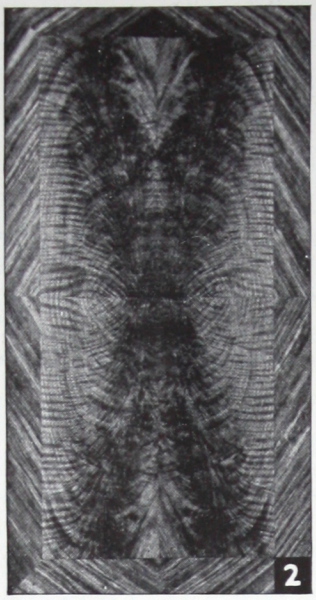


Walnut Plywood in elevator cabs at Trinity Building, New York.

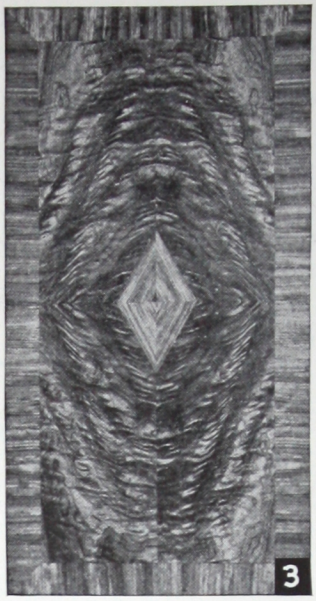


Mahogany Plywood piano case.

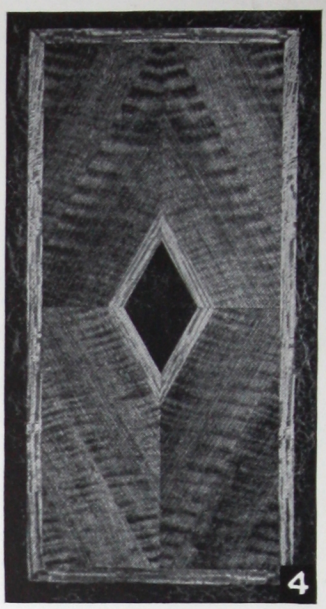
Rotary-cut Walnut Book-matched.



Crotch Walnut, field 4-way match with Bubinga border laid diagonally.



Stump Walnut field. Bubinga border and diagonally cut and matched diamond center.



Figured Sliced Quartered Walnut. Field, diagonally cut book and end—matched; Diamond center, Redwood burl; Inner borders, Satinwood; Outer border, Redwood burl.

THE RANGE AND FIGURE OF WOOD

There are thousands of different woods which are cut into veneers but our list† is limited to those which can be obtained from the leading veneer houses for prompt delivery. These woods present a wide variety of color and figure and when it is remembered that each species of wood has a wide variation of color and figure and that cutting methods vary these further, it will be seen that obtainable effects are limitless.

† *(See list on page 31)*

The appearance of any species of wood is determined by:

1—GRAIN—which is the physical arrangement of cells or fibres.
2—FIGURE—which is the characteristic marking, usually across the grain, of individual trees.
3—METHOD OF CUTTING—(See page 7).

Taking as an example a wood as generally well-known as Walnut, the following types are obtained:

1—Sliced Walnut
2—Plain Quartered Walnut
3—Figured Quartered Walnut
4—Half-round Walnut
5—Rotary Walnut
6—Butt Walnut (Stumpwood)
7—Feather Crotch Walnut
8—Burl Walnut
9—Claro Walnut (California)
10—French Walnut
11—Circassian Walnut

If we were to examine the variety which the arrangement and design of Walnut on a panel can produce, such as diamond-match, reverse diamond, squares, book match, etc., it becomes apparent that hundreds of distinctly different effects are available in one wood—WALNUT—alone. This is equally true of most cabinet woods.
For your convenience in identifying woods, we append a chart which merits careful study. See page 31.

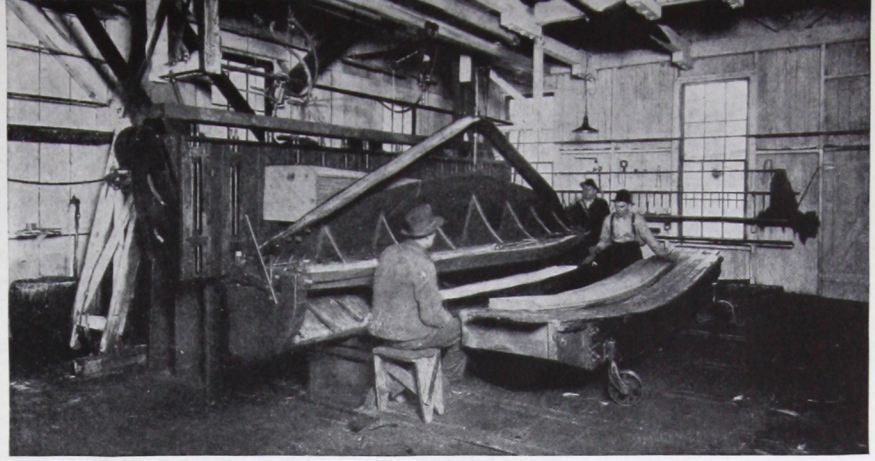
Fig. 1 Sliced Walnut

Fig. 2 Plain Quartered Walnut

Fig. 3 Figured Quartered Walnut

Fig. 4 Half-Round Walnut

Fig. 5 Rotary Walnut



Veneer slicer in operation. The steamed log descends against a stationary knife.

THE MANUFACTURE OF PLYWOOD

American standards of Plywood construction have been developed to produce a well behaved product. There are fifteen or more processes involved in the manufacture of fine Plywood from the cutting of the veneer to the sanding of the finished product. These, including the various gluing methods, are treated under separate headings.

VENEER CUTTING

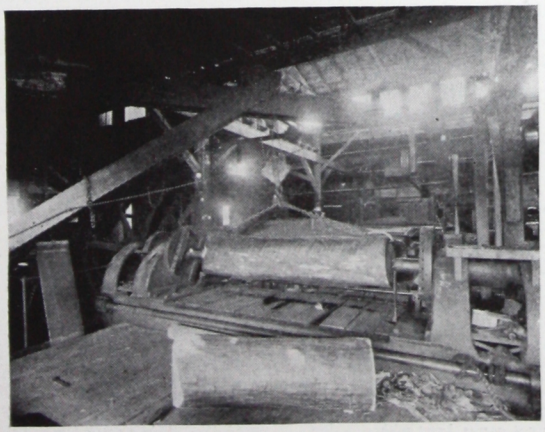
Without considering the technique of manufacture, veneers are produced as follows:

SLICED Cut on a long heavy knife after steaming or boiling the flitch. This is the method almost universally used in making fine veneers. The figure and grain may be partially determined by the position of the flitch in the log.

ROTARY CUT Done on a lathe permitting the log to revolve against a knife. As these cuts are in part along the arc of the annular rings, the figure produced is fairly wild and therefore undesirable excepting in diffuse porous woods such as Birch and Maple. Rotary cutting, though frequently done on Walnut and Oak is practiced only where price is the determining factor and for centers and crossbands.

HALF-ROUND This type of cutting is done on a lathe, the log being held off center. The figure is a compromise between rotary cutting and slicing. The results are often pleasing and veneers of wide width may be obtained.

SAWN Excepting for heavy veneers and in quartering Oak, sawing is infrequently done because of the waste involved—approximately 1/16″ of the wood being wasted for each veneer obtained. It is the only satisfactory method of making Quartered Oak veneers because the flake or figure produced by exposing the medullary or pith rays is shattered in slicing. Sawing however produces the best veneer as it leaves the wood fibre undisturbed.



Picture of a veneer lathe with walnut log centered ready to begin cutting into veneer.

Rotary cut walnut veneer being torn and matched as it comes out of the lathe.

VENEER THICKNESSES

Practically all of the fine woods such as Walnut, Mahogany, Avodire, Satinwood, etc., are sliced 1/28″ in thickness. Birch, Maple, Oak and Ash are usually cut 1/20″ in thickness, either rotary cut, sliced or sawn. Any of these veneers are obtainable in other thicknesses. Unless there is some good reason for selecting other than standard veneer thicknesses, such as for doors or other purposes involving hard usage, standard veneer thicknesses should be specified. There is a considerable price penalty for using non-standard thicknesses and no selection from existing stocks is possible. Odd thicknesses must usually be cut to order and since the figure and type of wood which any log or flitch will produce can only be approximately predetermined, the advantage of adhering to standard veneer thickness is obvious. Thin face veneers are technically and practically better than thick because internal stress is practically eliminated and glue impregnation holds the fibres together. In using a 1/28″ veneer on the face of a panel, the remaining veneer thickness, after sanding, is approximately 1/32″. This is standard practice.

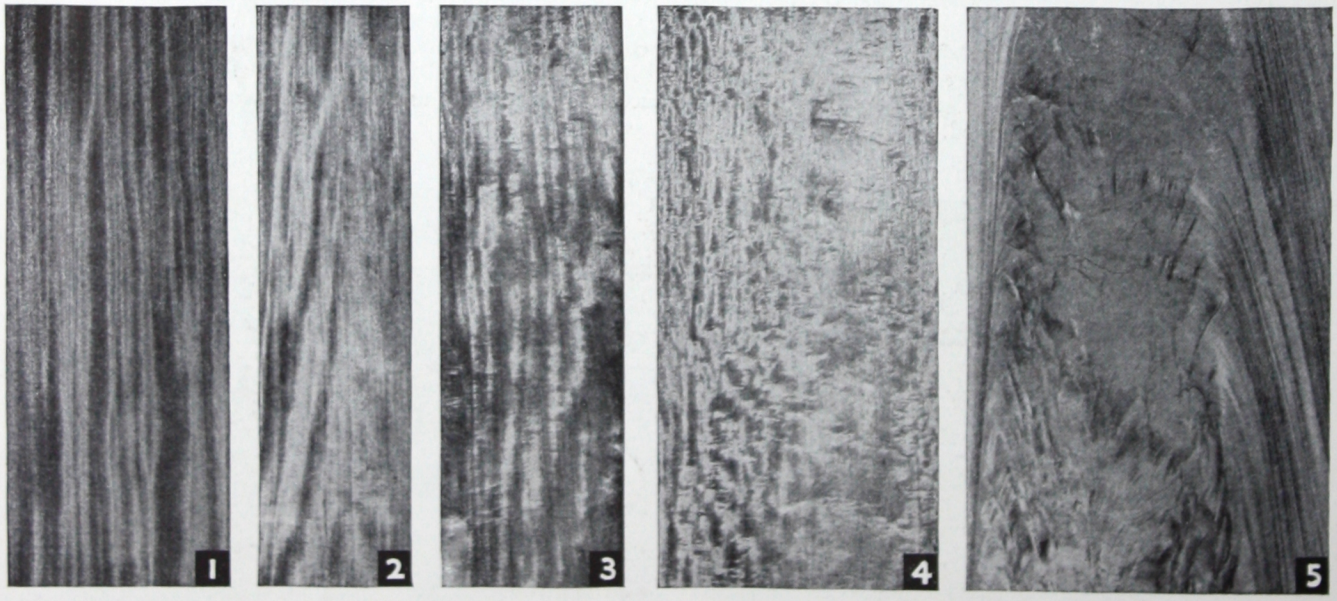
The standard veneer thickness on doors and door stiles and rails is 1/8″.

Veneer can be sliced as thin as 1/150″ and on some woods as thick as 1/8″. When greater thickness is desired, veneers must be sawn.

VENEER SAMPLING

In cutting veneer, the log is divided into sections called flitches. These flitches are steamed or boiled and then sliced by means of a heavy mechanical knife. As the figure or defects frequently change in cutting through the flitch, samples are chosen showing the top, bottom and center of the flitch. Sampling by means of a single piece of veneer is frequently misleading and often results in the choice of veneer which will not prove satisfactory either as to figure or dimension. Obviously it is necessary to be certain that the veneer, after trimming, is long enough to cover the maximum panel length and that too much waste is not involved. In most sound woods like Walnut or Mahogany the quantity of veneer required is double the surface area of the Plywood. With Butts, Crotches or Burls it may require from four to six times the footage to cover a given area due to defects and shape irregularity.

MAHOGANY VENEER



Quartered Mahogany Stripe Figure

Broken Stripe

Broken stripe with Mottle

Veneer cut across heart with a marked mottle figure

Swirl Crotch

THE MANUFACTURE OF FACES

After the veneer is cut the sheets must be prepared for final gluing into Plywood and the important steps to consider are drying of the veneer and the subsequent manufacture of matched faces. The veneers are dried in a long heat and humidity controlled mechanical dryer. The sheets go in one end wet and come out of the other end dry and flat. The veneer then passes through a platen re-dryer. This type of dryer consists of a series of smooth flat steam-heated leaves or platens which are alternately squeezed together to flatten the veneer and opened up to allow the moisture to escape from the wood surfaces.

The most important procedure from the angle of final appearance of the Plywood is the manufacture of the faces after the selected veneer has been cut and dried.

The veneer is first cut by clippers to dimensions approximately one inch longer and wider than the finished dimension to allow for final trimming after gluing. The veneer is then laid out to insure the best effects possible, special care being taken on architectural Plywood to make certain that the most prominent panels receive the best parts of the flitch.

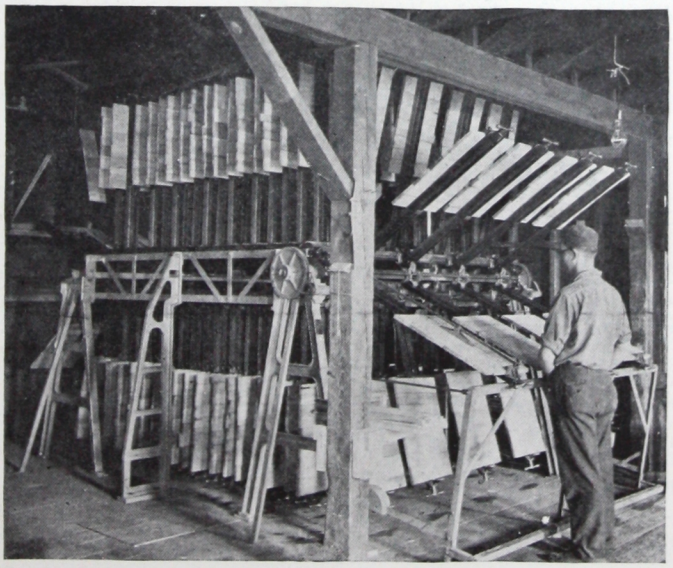
The veneers are then put through an edge jointer to insure perfectly tight joints and are taped. Special care is taken that the character and figure as well as the color of the adjacent pieces of veneer are accurately matched at each tape joint. In addition to taping the veneers in a face, it is standard practice with us to glue the edges of the veneer together under the tape. This is done by folding back the joints after taping and passing the exposed edges over a small glue roller.

Two-piece figured Sliced Walnut

CROSSBANDING AND CORE STOCK

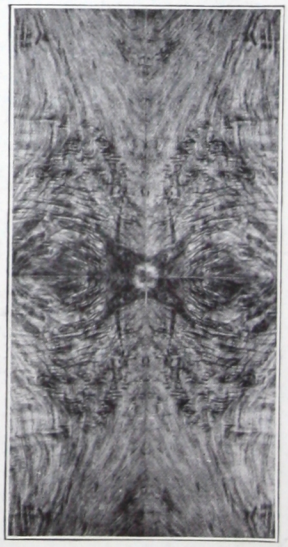
Only one-piece crossbanding of soft textured woods (usually Poplar) should be used under face veneers as there is a danger of joints showing after the plywood is finished when jointed crossbandings are used. Veneer selected for the backs to properly balance the face veneer must be of similar type and density.

In the manufacture of lumber cores selected Poplar and Chestnut are used. The lumber is kiln dried to 3-5% moisture content and then dimensioned for required sizes after which it is jointed and planed and ripped into narrow strips of 3-4 inches. These strips are edge glued and placed in a rotary clamp and allowed to dry until the glue sets. The cores are then placed once again in a kiln for drying and this is a most important step as the gluing process has increased the moisture content of the narrow lumber strips and this moisture must be removed. After redrying the cores are planed to required thickness and are then ready for use in the manufacture of the Plywood itself.



COURTESY OF JAMES L. TAYLOR CO.

A Rotary Clamp Machine in which narrow lumber strips are edge glued for Plywood cores



4 piece side and Butt matched Stumpwood (Butt)

THE CONSTRUCTION OF PLYWOOD

It has already been explained how the crossing of the grain of alternating plies accomplishes the purpose of rectifying the physical inequalities of wood. In making Plywood the laminæ are so combined as to balance.

STANDARD HARDWOOD CONSTRUCTIONS

	*Faces & back**	*Core*	*Crossband*
1/8" —3-ply Rotary (Veneer) core	1/20"-1/28"	1/20"	
3/16"—3-ply Rotary (Veneer) core	1/20"	1/8"	
1/4" —3-ply Rotary (Veneer) core	1/20"	3/16"	
5/16"—5-ply Rotary (Veneer) core	1/20"	1/8"	1/20"
3/8" —5-ply Rotary (Veneer) core	1/20"	1/8"	1/12"
1/2" —5-ply Rotary (Veneer) core	1/20"	3/16"	1/8"
5/8" —5-ply Rotary (Veneer) core	1/20"	3/16"	3/16"
13/16"—5-ply Lumber core	1/20"	11/16"	1/20"

* *Before sanding.*

The above construction practice will vary somewhat. When 1/28" faces are used, core stock will be cut full. In all cases it is important that corresponding plies on opposite sides of the core be of similar thickness and character in order to balance the Plywood properly.

In certain cheaper grades of Plywood, equal plies of rotary cut veneer are used to produce a required thickness. This construction is also used for special types of Plywood, i.e., Maple die-board stock.

GLUES USED IN PLYWOOD CONSTRUCTION

RESINS

The advent of resin glues, or certain of them, marks the most important development in Plywood manufacture. The resultant product is at once absolutely waterproof and the glue line impervious to bacterial deterioration. The wood itself is rendered impervious to rot for a depth of 1/16″ adjacent to the glue line. Plywood made under this process is also impervious to alcohol, oil, mild acids and alkalies.

The phenolic resins (Bakelite type) are the most important. They are derived from carbolic acid (phenol) and formaldehyde. The manufacturing procedure is a completely dry process. The resin, either in the form of an impregnated fibre sheet, dry powder or dried coating, is spread on the inner veneers. These are then subjected to heat and pressure until the resin is converted into a thin sheet having the general qualities of Bakelite.

Other resins, especially those in the lower price range, are used with varying results.

Plywood made with phenolic resin glue is practically welded. Hence our product so manufactured is marketed under the trade-marked name "Weldwood." (See page 23.)

COLD RESIN GLUES

The resin glue described in the foregoing is applied under heat and pressure and when perfectly handled, produces a perfect product. Yet the process itself is quite delicate and human fallibility is always something of a hazard when heat penetration, pressure and moisture content of veneers must be calculated within narrow limits. Too, the removal, through heat, of practically all moisture so that Plywood must be dipped or sponged after pressing, at times introduces undesirable stresses. The possibilities therefore of obtaining the same results without the application of heat would seem to make for a most desirable type of adhesive. A cold resin glue has been developed which achieves similar results to those obtained by the hot plate resins simply, safely, at less cost. As they contain no water, these resins introduce so little moisture into the panel that redrying is not necessary.

VEGETABLE

The base of vegetable glues is usually cassava flour (Tapioca). The resultant glue line is strong and enduring but has little water resistance. At least 90% of the commercial hardwood Plywoods are glued with vegetable glue because of low cost and easy adaptability to manufacturing processes. It may be classed as generally satisfactory when properly used for indoor installations and furniture which is not to be used in damp climates.

HIDE OR ANIMAL

These glues, derived from hides or bones of cattle, vary greatly in quality and price. They are rarely used in Plywood manufacture except for laying certain delicate face veneers which stain easily and in the manufacture of fireproof Plywood where other types of glue except resin, seem to deteriorate in contact with fireproofing salts.

CASEIN

The base of these glues is casein, the precipitated solids of skimmed milk. These glues vary in quality depending upon the quality and uniformity of the casein itself and the formulæ of the glues. In general, they produce a highly water-resistant Plywood, permanent and of great strength. Plywood properly made with casein glues will withstand any climatic conditions including high moisture and humidity, but cannot be classified as waterproof.

BLOOD-ALBUMEN

The base of these glues is dried slaughter-house blood and they set or coagulate under heat. The process requires a hot-plate press between the platens of which the panels are heated under pressure. These glues are somewhat higher in water-resistance than the casein glues. The process makes the Plywood somewhat more expensive and, as the added degree of water-resistance is negligible, the use of blood is limited. It is sometimes used in conjunction with casein but these glues do not command an important place in Plywood production, especially as they frequently deteriorate through bacterial action.

SOYA BEAN MEAL

The meal made from ground Soya beans, sometimes called vegetable casein, is not unlike the casein glues in its performance, especially on soft or coniferous woods such as Fir and Pine. While it is an inexpensive glue, it falls into that rare category of products which are at once cheap and good. Like all glues, its performance depends on its formula and skillful use. Practically all Fir and Pine Plywood is made with Soya Bean Meal glue.

SPREADING

After the veneers and cores are assembled they are passed through glue spreaders which accurately regulate the amount of glue needed for the best results. Some glues will stain certain woods if the glue is spread too heavily, or if its viscosity is too low; hence, both the preparation of the glues, and their application, are delicate and important operations.

PRESSING

The cold glues require pressure of from 100 to 200 pounds per square inch, which is obtained in an hydraulic press. This pressure is held usually over night by means of retainers. Heavy caul boards of hard wood, well waxed, are interposed between sets of panels to insure uniformity of pressure and freedom from warp.

The process used in making the resin glued plywood (WELDWOOD) embraces the use of a hot plate press having a number of openings. The glue, usually in sheet form, is dry and the hot plates are brought down upon the veneers, the heat and pressure forming the panels. This sounds exceedingly simple and it is, in theory, but when pressures, time for heat penetration, moisture content, etc., must be calculated on various thicknesses and types of wood, it will be seen that skill is required for uniformly perfect results.

ASSEMBLING OF PLYWOOD

REDRYING

Plywood must be "stuck" and re-dried in heat and humidity controlled kilns, after gluing, to eliminate excess glue moisture —unnecessary, of course, where the hot plate press is used.

SANDING

All fine plywood is passed through triple drum, endless bed sanders, and is then polished to a smooth finish under belt sanders. The finish is, of course, very important both to insure a smooth surface and to avoid extra labor on the job; this, too, is an operation in which skill is an important factor. Uneven sanding causes warpage.

TRIMMING

This operation is performed on equalized saws insuring perfectly rectangular cuts.

PACKING

Plywood is packed in heavy wooden crates under pressure, to keep it flat and avoid chafing.

THE GRADING OF PLYWOOD

The technical grading rules of Plywood permit many defects which are not found in Plywood of good manufacture and unduly complicate a really simple matter. The grades under which our Plywood is produced are listed herein. It should be remembered that these rules do not specify the fifteen or more processes which must be skilfully and scientifically followed to make an unassailable product.

CABINET GRADE

Cabinet grade panels are so manufactured as to meet the exacting requirements of fine cabinet work. They will show no defect under any finish and are made of highly figured and specially selected veneers, smoothly sanded and polished.

STANDARD GRADE

Standard grade panels are well made, faced with plain veneers, frequently rotary-cut and so designed as to be satisfactory where a generally pleasing effect at moderate cost is desired.

EXAMPLE: A ¼" CABINET grade Figured Gum panel is faced with very highly figured veneer, center-matched, mounted on a one-piece core, the face veneers being edge glued.

A ¼" STANDARD grade Figured Gum panel is faced with a mildly figured veneer, may contain sap, is not center-matched and may be produced with a pieced core.

Both Cabinet and Standard grades are made in good one side and good two sides.

GOOD ONE SIDE

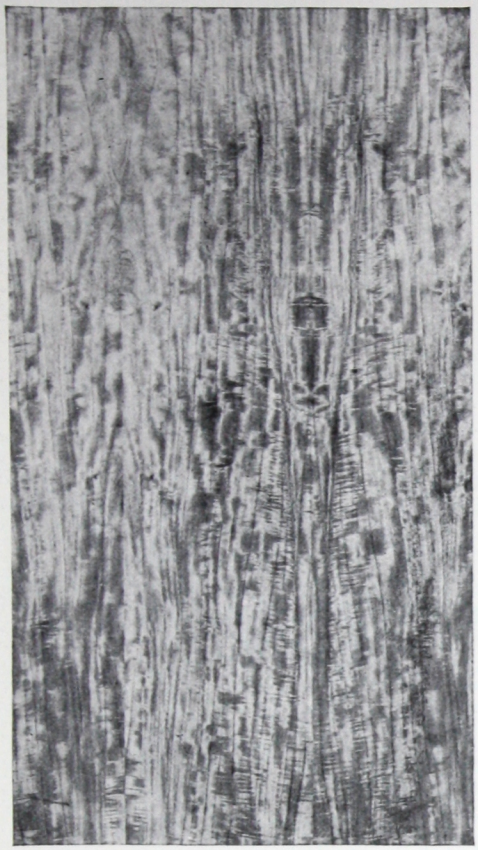
This grade means that one face of the panel is entirely free of defects of any kind.

GOOD TWO SIDES

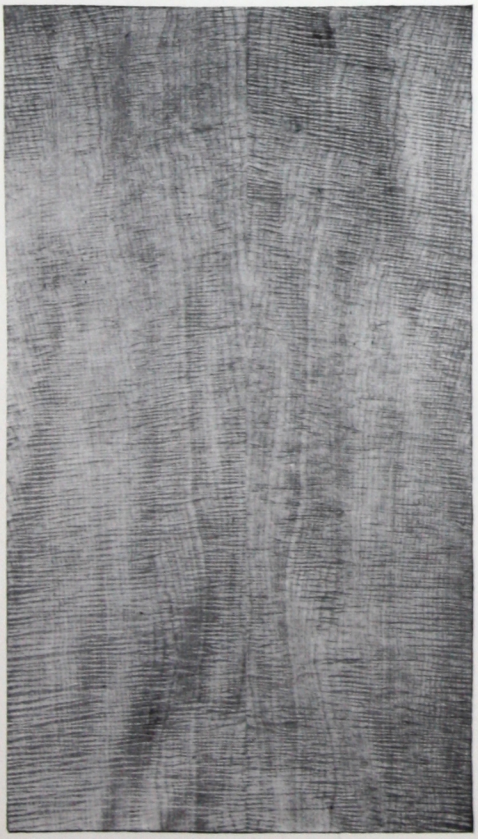
Both sides of this grade are of the same wood and entirely free of defects. This grade is used when both sides of the panel are exposed.

SOUND OR DRAWER BOTTOM

This grade presents one surface or side which is without open defects but permits of occasional sound knots, discoloration and unmatched figure.



Prima Vera



Grey Harewood

Stock PLYWOOD

Plywood is made where the trees grow. Fir and White Pine panels are made on the Pacific Coast. The fine hardwoods are manufactured in Michigan, Wisconsin and upper New York State. Hardwood Plywood of Gum and the lower priced woods emanate from the South. Each type of Plywood has a definite place in industry.

In order to make these products from widely scattered sources readily available and to eliminate the excessive cost of manufacturing and shipping small quantities, they are brought to warehouses in carloads and shiploads.

The sizes and thicknesses in each type of product have been standardized in accordance with trade practice. The cabinet maker lays out his work with these sizes in view, as do many architects. To make Plywood properly takes time and when time in transit is added, mill shipment is too slow for many projects.

Considering the variety of color and figure in each of the woods, it is often important to see the actual material which is going into a job. Thus the architect and his client may examine and select. Many of the finer woods are carried in matched sets for the fine job which must be done quickly or for those who prefer to see the actual material made up rather than to judge its appearance from the veneer samples.

The United States Plywood Company, Inc., carries the largest stock of Plywood panels in the world in a network of warehouses from Coast to Coast, established at strategic points. While the priced catalogue (sent on request) goes into detail as to the various types, sizes and thicknesses carried, in general, they are as follows:

DOUGLAS FIR

Thicknesses	3/16″, 1/4″, 3/8″, 1/2″, 5/8″, 3/4″
Widths	24″, 30″, 36″, 48″
Lengths	48″, 60″, 72″, 84″, 96″, 120″

WHITE PINE

Thicknesses	1/8″, 1/4″, 3/8″, 1/2″, 5/8″, 3/4″
Widths	24″, 30″, 36″, 48″
Lengths	60″, 72″, 84″, 96″, 120″

HARDWOODS (Ailon, Birch, Basswood, Duali, Gum, Mahogany, Maple, Oak, Orientalwood, Knotty Pine, Poplar, Walnut)

Thicknesses	1/8″, 1/4″ 3-ply	3/8″ 5-ply	1/2″ 5-ply	13/16″ 5-ply
Widths	24″, 30″, 36″	24″, 30″, 36″	24″, 30″, 36″	24″, 30″, 36″, 48″
Lengths	48″, 60″, 72″, 84″	60″, 72″, 84″	72″	60″, 72″, 84″, 96″

(Counterfronts 144″ x 28″, 36″ and 42″)

All combinations of lengths and widths are carried in panels good one side and good two sides.

For practical purposes, Plywood is divided into two main headings:

SOFT WOODS: Fir and Pine.

HARDWOODS: Plywood faced with hardwood veneers covering several hundred species, most of which are listed on page 31.

The subject of Plywood from the angle of availability or distribution is likewise divided into two classifications:

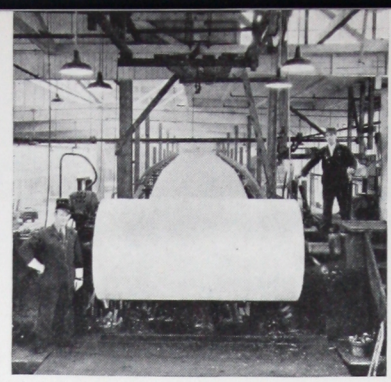
STOCK PANELS: Plywood of standard stock sizes carried on hand for immediate delivery from warehouse.

MILL SHIPMENTS: Plywood manufactured on order to specifications required.

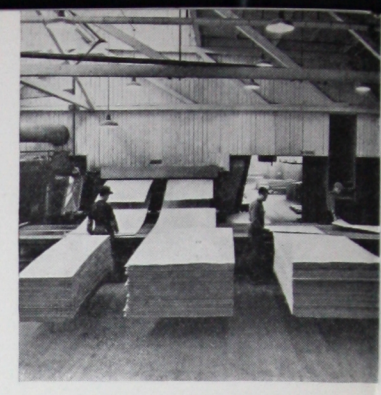
Among the panels carried in stock will be found a number of inlaid figured panels for window backs, Aircraft Plywood, Weldwood—waterproof Plywood for marine or technical use—Fireproof Plywood, ARMORPLY—metal-covered Plywood—stiles and rails, die-boards, profiles, MICARTA.

The United States Plywood Company, Inc., maintains a fleet of trucks at all of its warehouses and makes immediate delivery of stock items upon receipt of orders.

1 *Sawing logs to length*



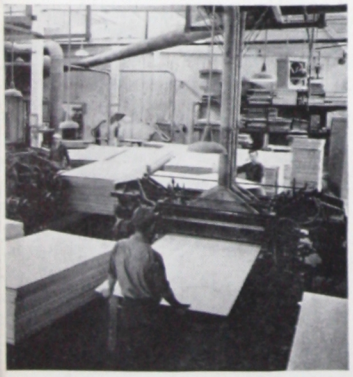
2 *Rotary cutting*



3 *Drying veneer*

4 *Glue spreading*

5 *Removing glued stock from hydraulic press in retainer clamps*



6 *Sanding by eight drum sanders*

DOUGLAS FIR Plywood

The great stands of timber still available in the United States are located in the States of Oregon, Washington and Northern California. Of these, Douglas Fir, sometimes called Oregon Pine, predominates. The trees grow to enormous size, not infrequently ten feet and larger in diameter and up to one hundred and fifty feet in height.

Fir plywood is carried in enormous quantities in warehouses throughout the country. The product of the better mills is largely faced with one piece, unjointed veneers. It is truly a universal product and is put to endless uses. Fir plywood is not recommended for high-class paint or enamel work because the grain will raise and tiny hair-line checks are likely to develop.

Fir Plywood is manufactured in the following grades: Good Two Sides, Good One Side, Sound Two Sides, Wallboard Sheathing.

FIR WALLBOARD

Fir Wallboard is cheaper, lighter, stronger and lends itself to a greater variety of finishes than any of the synthetic wall boards. All of the latter are much the same, differing little in their basic materials, and at best are nothing more than glorified pasteboard. They have little tensile strength, are suitable only for paint finishes and, because of their porosity, require more paint to cover. Were it not for the extensive advertising and merchandising done by the various synthetic board manufacturers, these products would rapidly disappear as factors in the market for they are not only demonstrably inferior to Fir Wallboard but cost more.

Perhaps the fact that Fir Plywood production has increased more than 300% during the depression as against a sharp decline in the production of competitive materials, indicates that, on merit alone, this product is finding its market.

Fir Wallboard is made with one good side, the back being defective.

FIR PLYWOOD FOR STRUCTURAL PURPOSES

For structural purposes, Douglas Fir Plywood is indicated because of its low cost, great strength, light weight and the ability to produce it in large sizes without premium. Sizes as large as four feet by eight feet are standard and larger sizes may be obtained at additional cost. This Plywood is of approximately the same strength in all directions whereas the tensile strength of lumber may be twenty times as high parallel to the grain as across it. Because of the large sheets, a saving of from 40% to 75% over the cost of handling and installing lumber is possible. Douglas Fir Plywood is of uniform thickness, smoothly sanded on both sides. It weighs less than 34 pounds per cubic foot.

CONCRETE FORMS

The use of Fir Plywood for concrete form work, though developed within the last few years, already runs into millions of feet annually. It produces smooth finless work. Concrete form Plywood is shipped oil-treated from the mill, or may be coated with form oil obtainable from any of the refiners at low cost.

Concrete form Plywood can be used from seven to ten times. It saves 40% to 75% of carpentry labor. It speeds up stripping. It gives smooth finless surfaces immediately. No costly rubbing or plastering is necessary. It is split-proof, non-bulging, ideal for reverse moulds. Large sizes reduce lineal footage of joints. It cuts with hand or power saws. Curves of sharp radius are possible. 1/4″ Plywood dry will take a 16″ radius; steamed for a few minutes it will take an 8″ radius.

SUB-FLOORING

Used as a sub-flooring, Fir Plywood offers a combination of economies with other advantages not otherwise obtainable. A thickness of 3/4″ 5-ply is generally used. It grips nails more tenaciously than lumber and, as it can not move appreciably because of its cross grain construction, it prevents open joints and squeaks. Fir Plywood is sold by the square foot in full measurement so that there is no tongue, groove or shiplap waste.

SHEATHING

For virtually the same reasons which recommend it for sub-flooring, Fir Plywood is superior to tongue and groove sheathing. 1/4″ thickness is usually used for this purpose. Tests at Leland Stanford University, details of which are available on request, show a minimum of elastic distortion, maximum load, maximum stiffness recovery and maximum resilience. This report recommends its use as sheathing especially in earthquake areas. See Prefabrication System, page 35.

Ceilings

Concrete Forms

Sub Flooring

PLYWOOD IN THE ARCHITECTURAL FIELD

ARCHITECTURAL PLYWOOD follows architectural specifications as to construction, size and type of veneer, samples of the actual veneer being submitted before manufacture. The veneer markets of the world are combed for rare and exotic woods and are submitted for architectural selection.

FLAT PLYWOOD can be made in one piece up to 12′ wide and practically any length in any thickness. It is necessary to bear in mind the length limitations of certain of the face veneers as well as the fact that very large panels carry a considerably higher price than those of medium size.

CURVED PLYWOOD may be obtained in any radius down to 6″ and is substantially more expensive than flat. Forms must be made for each curvature. We have a large number of curved forms at our mill for the use of which no charge is made. Blueprints of such forms or templates are available on request. All special panels are made to match, are numbered on the blueprints and on each unit to insure the proper placement of the panels for a desired effect.

At least three weeks should be allowed for delivery of custom-made Plywood, though delivery in ten days is sometimes possible. Because of the gluing and drying processes, a reasonable time for manufacture should be allowed whenever possible.

FIREPROOF PLYWOOD. This product should, of course, be called fire-resistant Plywood. It is manufactured to conform to the laws of the City of New York where all such material for buildings over one hundred and fifty feet in height must conform to certain tests performed by Columbia University.

The core of these panels is made of lumber which has been made fire-resistant by the impregnation of certain salts under pressure. The principle involved is to immerse the boards in a tank filled with saline liquid under pressure. When these boards are redried, the tiny particles of salts remaining in the cells of the wood prevent the entrance of oxygen to support combustion. Furthermore, the salts under heat give off carbon monoxide gas which is a strong fire retardant. Various types of salts are used and their general performance depends largely upon the depth of impregnation.

The New York City laws permit 1/16″ of non-fireproof wood on either side in one or two plies. Fireproof panels are sometimes made of treated veneers in veneer construction, especially when they are curved.

Probably the finest example of this type of work is the Men's Bar of the Waldorf-Astoria Hotel. All of these panels are of very large size and are faced with inlaid exotic woods.

Those interested in fine Plywood work would do well to visit this room designed by architects Schultze and Weaver and erected by Jacob Froehlich & Sons from Plywood manufactured by us.

There are other means of securing fire-resistant results with Plywood, such as the use of any of a number of asbestos products in sheet form glued on the inside of a panel, hard asbestos sheets glued on the outside of a panel, and metal-faced Plywood such as ARMORPLY.

Men's Bar, Waldorf-Astoria Hotel, New York City.

ARCHITECTS: SCHULTZE & WEAVER

INSTALLED BY:
JACOB FROEHLICH CABINET WORKS

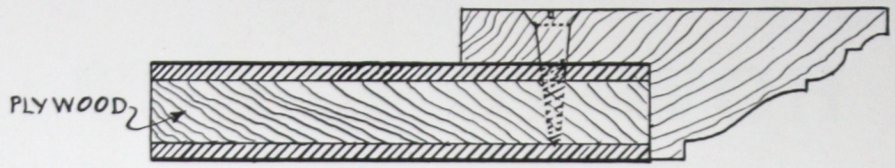
All flat and curved wall surfaces and bar front are Fireproof Plywood faced with Brazilian Rosewood, French Walnut, and Carpathian Elm Burl.

HOW TO ERECT PLYWOOD

We have attempted to explain and illustrate the appearance of various woods and the manner in which they may be assembled in Plywood form in other pages of this book. We have then to deal with sheets of Plywood of practically any thickness, length or width faced with any of a large variety of woods, or several of them in such design as may best suit the effect desired. Our purpose here is to explain how these panels are to be erected.

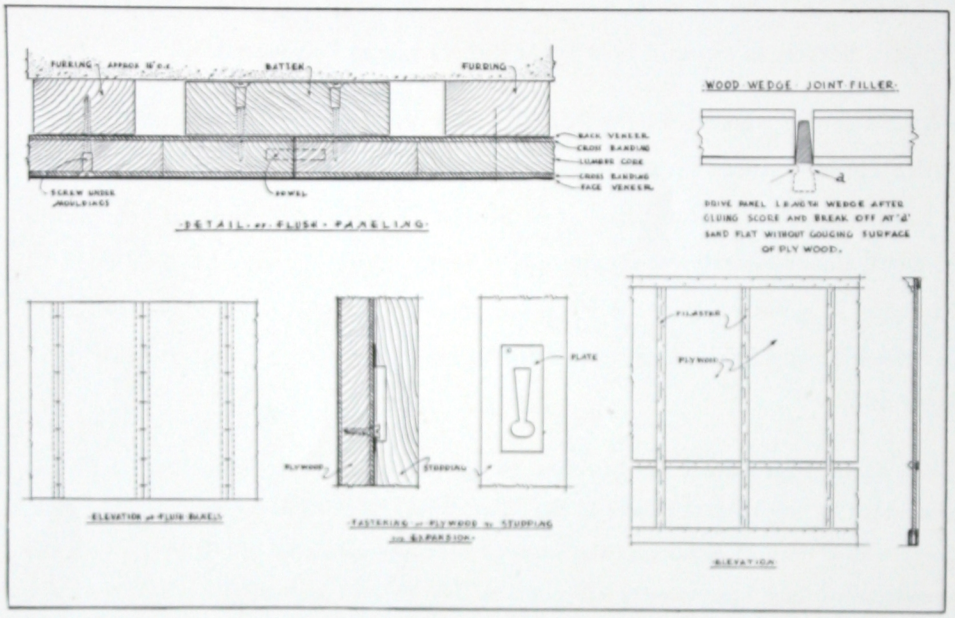
Any structure should be reasonably dry to receive Plywood. Wood is hydroscopic. It takes on moisture and while Plywood, especially Weldwood, is unaffected in its glue lines, it is unwise to offend the natural tendencies of wood unnecessarily. Warpage might result. Painting the back and edge of Plywood is good practice. A Plywood installation will outlive any building in which it is installed. There is no upkeep, only occasional re-waxing is desirable.

THE FINE PLYWOOD JOB, either in period or flush construction, is always assembled by the cabinet maker in his shop. Such Plywood is usually 13/16″ thick, 5-ply with a core of lumber in the form of narrow strips edge glued over which the crossbanding and face veneers are applied. The cabinet maker will edge glue these panels to each other, dowel them every nine inches, and will further insure against separation and open joints by screwing battens the full length of the panels behind each joint. He will then build the panels into sections of such size as to permit their passage through the elevators or doors of the building, fastening the sections to the studding, which must be level, or on to the walls. The methods vary according to local conditions and the type of room. Large flush surfaces must be so treated as to accommodate expansion and contraction because, while the crossing of the grain of the wood in alternate layers minimizes expansion and contraction, it does not entirely eliminate it. Especially in wide expanses such as twenty feet or more, the sections must be hung on metal in a manner such as to permit their movement or a space of an inch or so on either end must be provided and covered with moulding. The maximum movement is generally 1/10 of 1% in either direction.



•DETAIL•of•RAISED•PANEL

RAISED PANELS are made by machining the edges of thick Plywood in accordance with the desired pattern and the corewood is either stained to match the face of the panel or the cores are banded with wood of the same kind when the panels are made, the latter of course being more expensive. Another satisfactory and cheaper method of achieving raised panel effects can be accomplished with 3/8″ panels set in specially run mouldings. (As illustrated.)

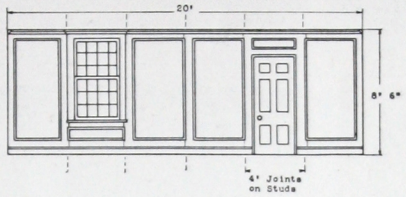


PERIOD DESIGNS, which frequently call for small panels with an elaborate moulding and carving, are usually built in the shop and assembled but it is possible to secure a satisfactory result by applying the panels to the studding by means of brads and applying the mouldings over the joints.

CONVENTIONAL PLYWOOD EFFECTS are simply and inexpensively achieved by nailing the panels to studding and covering the joints with mouldings. This is a perfectly satisfactory procedure as there is no appreciable expansion or contraction in any single panel. Where the panels are to be applied over plaster walls, furring strips must be used. The thickness of the panels may be 1/4″ or thicker and of course of any kind of wood. Where for instance a cellar is to be converted into a game room, Fir Plywood may be so erected at a surprisingly low cost and a living room or dining room may be lined with Walnut or Mahogany at a cost far less than is generally believed possible.

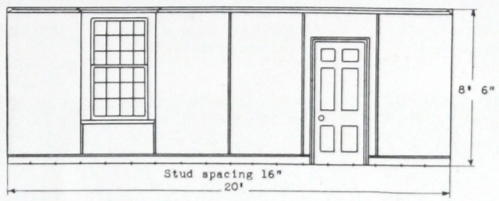
PANEL USAGE—In Order of Expense

1/4" 3-PLY ROTARY PINE OR FIR PANELS
4' x 8' APPLIED TO STUDS



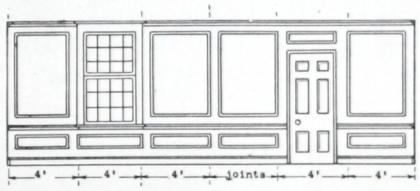
3/8" 3-PLY — 4' x 8' — OTHERWISE AS ABOVE
ADVANTAGE OF (2) — INCREASED RIGIDITY AND THICKNESS
3/4" 5-PLY — 4' x 8' — OTHERWISE AS ABOVE

4' x 8' PANELS ON STUDS AND APPLIED MOULDINGS
PANELS CAN BE 1/4" — 4' x 8' 3-PLY OR 3/8" — 4' x 8' 3 OR 5-PLY



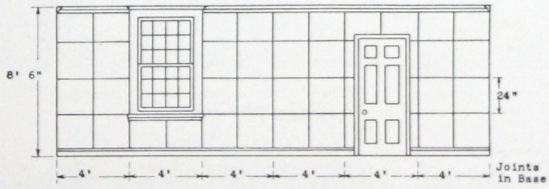
THIS SCHEME IS BASED ON THE USE OF LARGE PANELS AND THE COVERING OF MOST OF THE JOINT BY AN APPLIED PANEL MOULDING SO PUT ON AS TO FORM A PANEL MOTIVE. IT SHOULD BE QUITE INEXPENSIVE AND SHOULD HAVE A WIDE APPLICATION FOR BOTH NATURAL FINISH AND PAINTED WOOD WALLS.

4' x 8' PANELS ON STUDS, APPLIED MOULDINGS AND CHAIR RAIL OR 4' x 6' PANELS



SIMILAR TO (4) EXCEPT FOR ADDITION OF CHAIR RAIL
ADVANTAGE OF (5) — SOMEWHAT BETTER FINISH THAN (4)
4' x 4' PANEL AREAS WITHOUT CHAIR RAIL COULD BE USED — WITH NO APPARENT ADVANTAGE

4' x 8' x 3/8" OR 3/4" FIR OR PINE PLYWOOD ON 16" STUDS
1/4" FINISH PLYWOOD APPLIED OVER THIS BASE



CAN USE 12" — 13" — 24" — 32" TOP PANELS.

CAN USE ANY FINISH WOOD.

CAN USE SQUARE BUTT JOINTS, "V" JOINT, INSERT STRIP NARROW OVERLAP MOULDING, ETC.

FINAL FINISH INDEPENDENT OF STUD SPACING.

CAN USE A VARIETY OF PANEL SIZES TOGETHER.

FOR FASTENING TOP PANELS USE CEMENT, NAILS OR BOTH.

DIRECTION OF GRAIN IN TOP PANELS CAN BE VARIED

DOOR CAN BE COVERED TO MATCH WALL.

THIS SCHEME IS APPLICABLE TO A GREAT VARIETY OF EFFECTS THROUGH THE USE OF DIFFERENT WOODS, SINGLY OR IN COMBINATION, CHANGE IN GRAIN DIRECTION, SIZE OF PANELS, INSERT STRIPS OR BEADS BETWEEN THE PANELS.

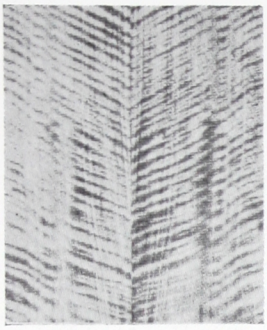
COURTESY OF BEHR-MANNING CO.

CROTCH—Shell Figure

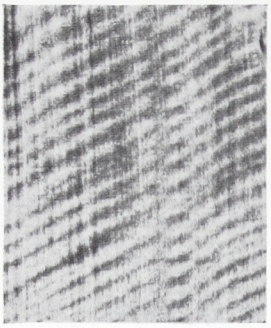
CROTCH—Moon Figure
2 piece matched

CROTCH—Feather Figure
2 piece matched

CROTCH

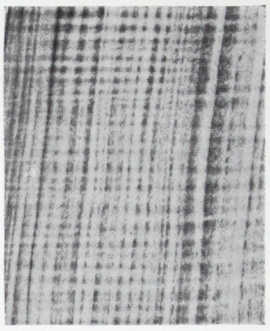


QUARTERED—Fiddle-back
Figure, 2 piece matched



QUARTERED—Rope Figure

QUARTERED—Figured Stripe
2 piece cathedral matched

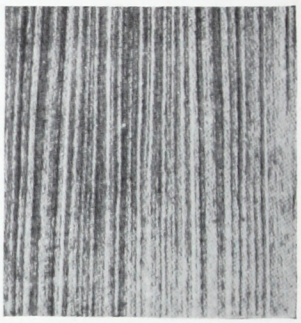


QUARTERED—Cross-figured
Stripe

QUARTERED—Flake Figure

QUARTERED—Broken Stripe

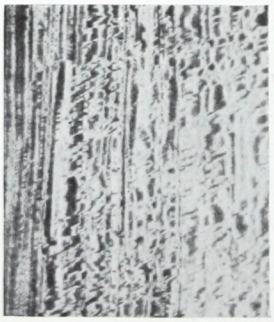
QUARTERED—Pencil Stripe
square matched



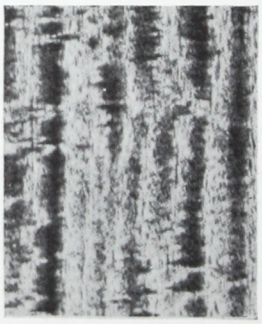
QUARTERED—Pencil Stripe

BASTARD CUT—Comb Grain

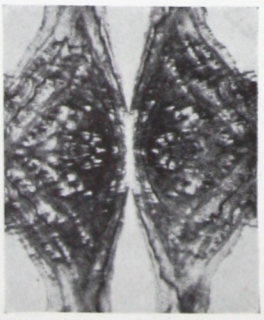
QUARTERED—Large Mottle,
block figure



QUARTERED—Small Mottle,
or Beeswing Figure



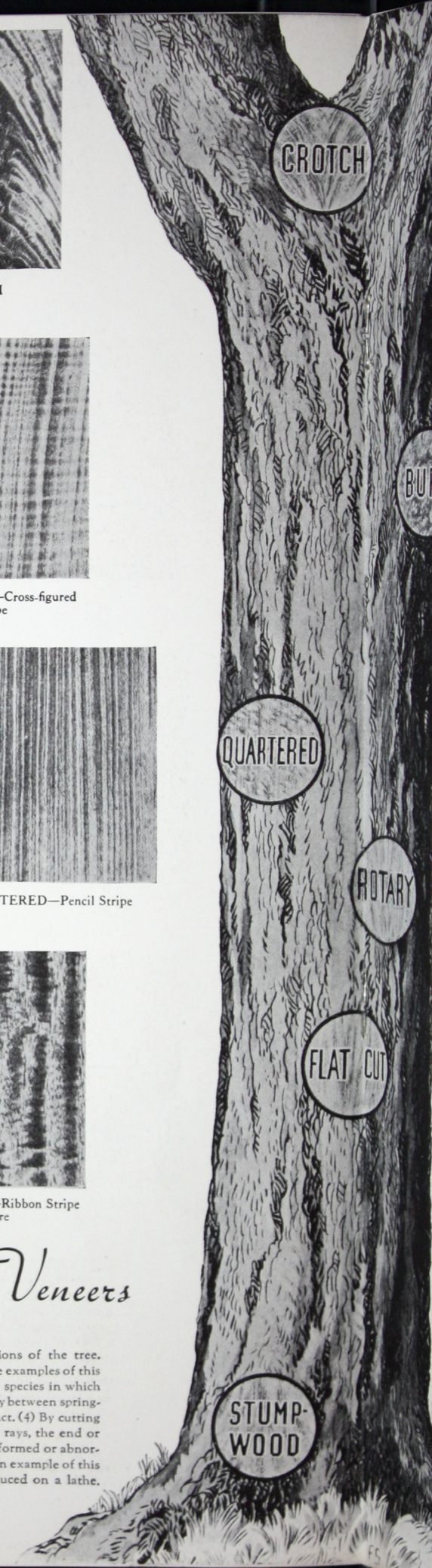
QUARTERED—Ribbon Stripe
Figure

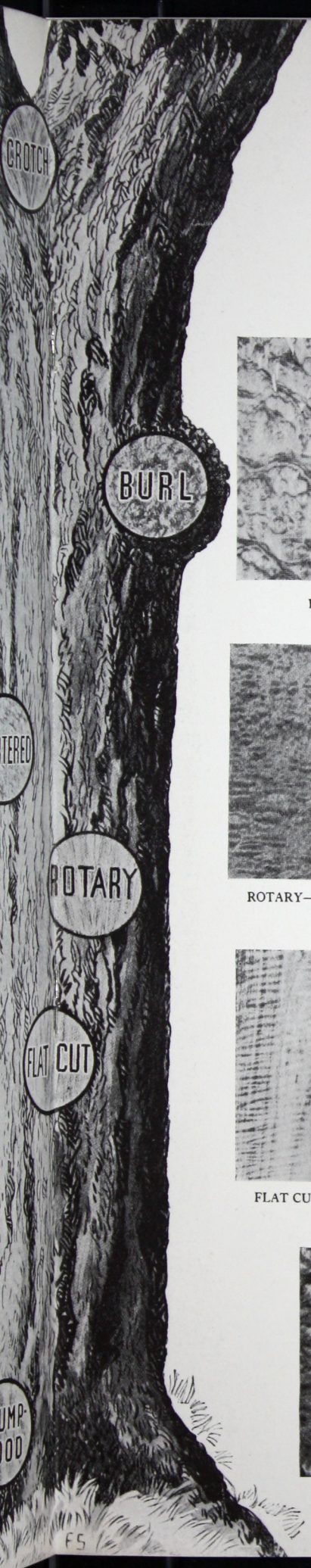


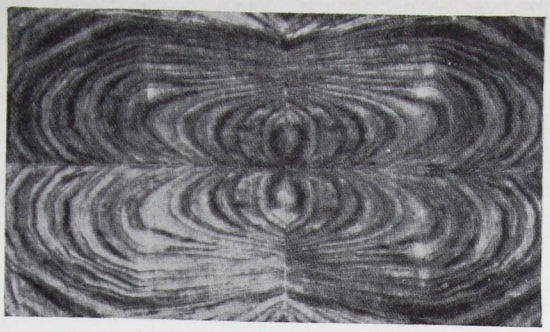
STUMPWOOD—Heart and
Sap Character

The Variety of Figures in Veneers

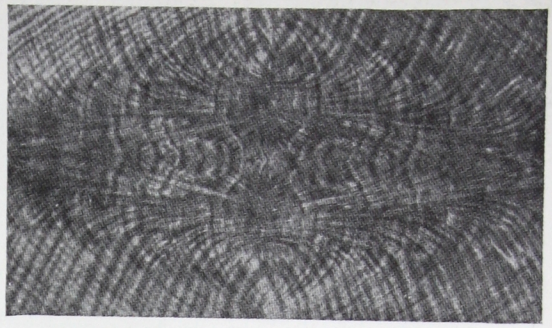
On this spread are presented actual photographs of veneers representing nearly all of the major types of figure which are generally encountered. The photographs are arranged for quick and easy reference. Figure types and grain character in veneers are determined in five different ways. (1) By varying the direction in which the knife or saw passes through the wood. The quartered and flat cut types are determined in this way. (2) By selecting different portions of the tree. Crotch and stumpwood types are examples of this selection. (3) By selecting those species in which the difference in color and density between spring-wood and summer-wood is distinct. (4) By cutting the wood in order to expose the rays, the end or curly grain. (5) By cutting the deformed or abnormal portions of a tree. Burls are an example of this method, and are generally produced on a lathe.



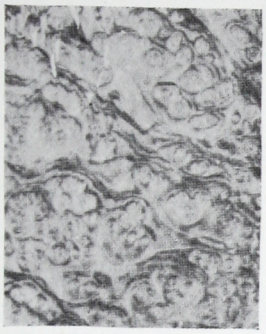




CROTCH—Shell Figure 4 piece matched



CROTCH—Figured 4 piece matched

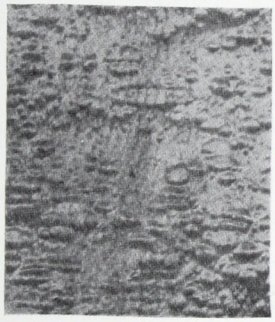


BURL

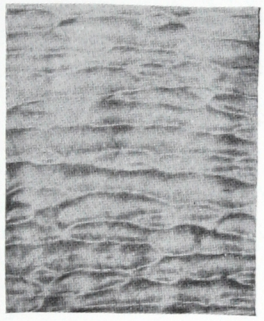
CROTCH—Swirl Figure

ROTARY—Plain

ROTARY—Figured

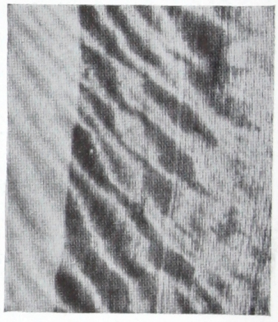


ROTARY—Blistered Figure

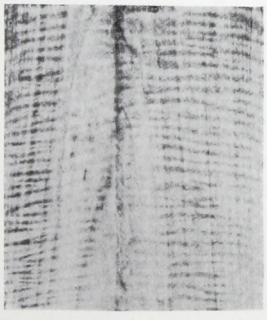


ROTARY—Quilted Figure

ROTARY—Birdseye Figure

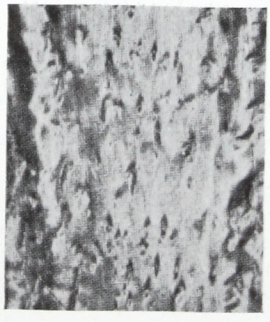


ROTARY—Curly Figure



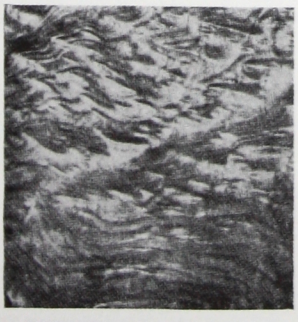
FLAT CUT—Cross Figured

FLAT CUT—2 piece matched



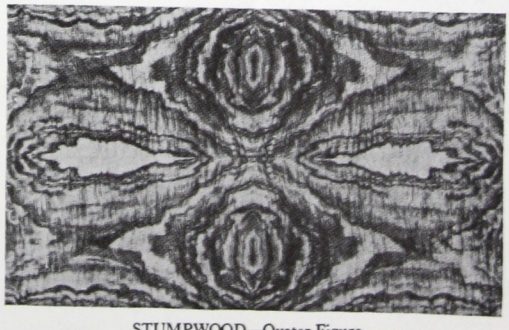
FLAT CUT—Plum Pudding Figure

HALF-ROUND—Plain
2 piece matched



STUMPWOOD—Highly Figured

STUMPWOOD—Plain



STUMPWOOD—Oyster Figure
4 piece matched

Reproduced through courtesy of the American Walnut Manufacturers' Association and "Homefurnishing Arts"

Pine Plywood painted white in B. Altman & Co., New York

CALIFORNIA PINE PLYWOOD

California Pine Plywood occupies a unique place in the Plywood industry. It is in the low priced field, fractionally higher in price than Fir. It has, however, a number of distinct advantages. It is lighter in weight, softer and of more uniform texture. It will paint or enamel far better than Fir because it will not check and the tendency of the grain to raise is slight. It is not a brash wood, permitting the edges to be smoothly moulded despite its veneer construction. California Pine Plywood lends itself admirably to re-veneering and effects substantial economies when so used as it is much less expensive than lumber strip cores and, as the surfaces are in a true horizontal plane, a sanded perfect surface is presented, entirely eliminating sunken joints frequently arising in improperly made lumber cores.

California Pine panels are made in all thicknesses and in sizes up to 60″ x 192″. Sizes larger than 4′ x 10′ however have scarf joints in the faces because of lathe limitations. The 1/8″ White Pine panel is a most useful product as it is extremely flexible and very useful for simple or compound curves.

California Pine Wallboard is less expensive than the synthetic boards and infinitely superior. It is stronger, stiffer, lighter, paints very much better and requires less paint because the surfaces are not nearly so absorbent.

DUALI*

The Least Costly Fine Hardwood Panel

Duali is our trade name for a Philippine wood of unusual characteristics which is manufactured into Plywood by applying the veneer to Fir cores or centres. By so doing a beautiful panel results, widely useful and at a cost substantially below any comparable product.

The wood is hard, its color ranging from light to dark tan. Duali stains Walnut, Mahogany, Oak with remarkable fidelity to the woods which it simulates and is a perfect paint base. The veneers, all of which are rotary cut, are cut 1/12″ or thicker eliminating any possibility of the Fir grain showing through the finish. Unlike many other Philippine woods, it is not hairy and nothing but the usual finishing procedure is necessary. While new in its present form, we have marketed millions of feet of Duali Plywood of different construction with complete satisfaction to our clientele, many of whom have favored us with letters praising its appearance and its behavior. All Duali Plywood is made with water-resistant glues and is available in standard sizes from any of our warehouses or cut to dimensions for direct shipment in straight carloads or with Fir Plywood from our mill at Seattle.

* *Trade Mark Registered.*

WELDWOOD * PLYWOOD is a trade-marked name given to Plywood manufactured under the resin process as described on page 11. It renders Plywood so manufactured absolutely waterproof and impervious to bacterial deterioration and for the first time makes possible an absolutely unassailable product.

Weldwood Plywood is being used for decks of sail boats. Weldwood can be safely used in damp climates without fear of separation and therefore should be specified in any woodwork, whether interior panelling or furniture, which is subject to a considerable degree of moisture.

Panelling in ocean liners and yachts as well as veneered furniture used aboard such vessels should be manufactured under the Weldwood process. We will unconditionally guarantee Weldwood Plywood against separation under all conditions. The additional cost is slight.

Resin gluing is undoubtedly the most important contribution to veneering. It has opened up for Plywood tremendous fields such as the pre-fabricated houses, outdoor signs and marine work where hitherto the use of Plywood has been very definitely limited because of the inability to produce an absolutely waterproof panel.

OUTSIDE WALLS

Weldwood has all the properties required for use in exposed places. A close grained surface wood such as Poplar or Birch is desirable for such use because the checking tendencies are less than on soft woods and because it presents a better painting surface with no grain raise. Weldwood in natural woods such as Walnut and Oak may be specified for exteriors including store fronts or building facades.

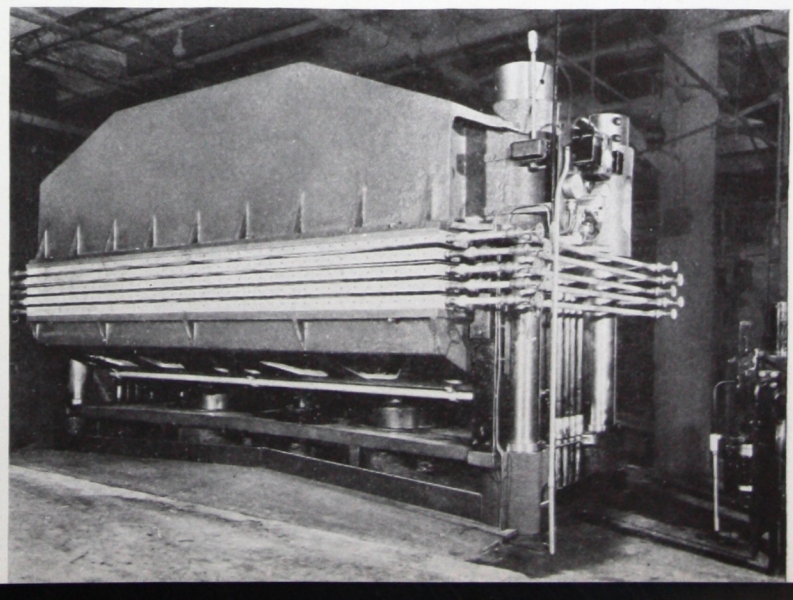
The Weldwood process has so extended the logical use of Plywood that architects and engineers must view it in the light of a new material.†

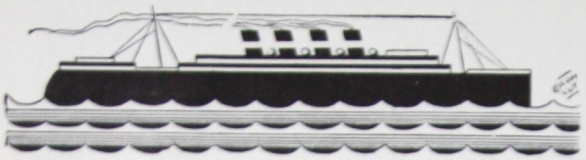
** Trade Mark Registered.*

† See table of engineering data, p. 33.

Amphi-craft COURTESY OF HERRESHOFF

Hot plate press COURTESY OF ALCOMA PLYWOOD CO.





PLYWOOD

IN SHIPBUILDING

We have manufactured the Plywood used in about 75% of the ships built during the last ten years. They include:

STEAMSHIPS

Bull Steamship Co.—Angelina
Bull Steamship Co.—Manuela
Dollar Line—Pres. Hoover
Dollar Line—Pres. Coolidge
P. & O. Line—Florida
Panama Pacific Line—California
Panama Pacific Line—Virginia
Grace Line—Santa Clara
U. S. Lines—Manhattan (Furniture)
U. S. Lines—Washington (Furniture)

YACHTS

Mr. Thos. F. Manville's Hi Esmaro
Mr. Wm. D. Stotesbury's Nedeva
Mr. J. P. Morgan's Corsair
Mr. Cornelius Vanderbilt's Winchester
Mr. Charles F. Dane's Vanda

Installations of our PLYBESTOS bulkhead panels are to be found in the following:
EXCALIBUR, EXCAMBION, EXETER, EXOCHORDA (AMERICAN EXPORT LINE)

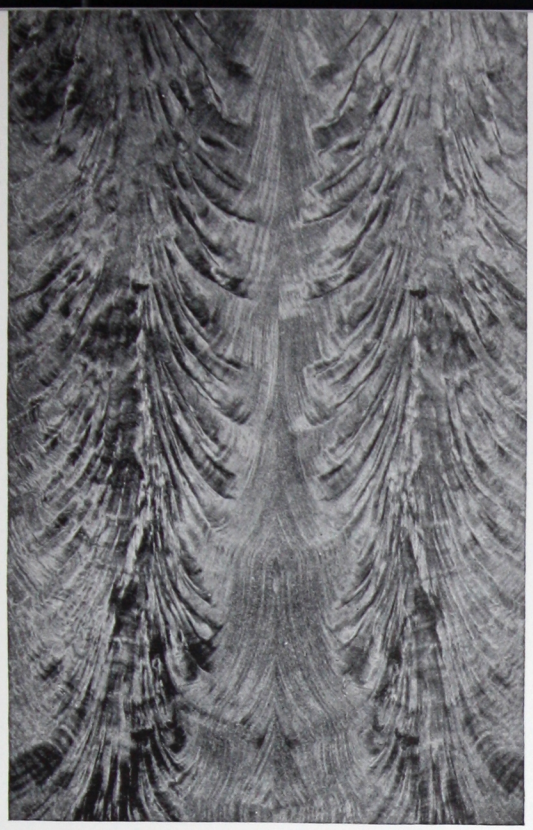
Installations of ARMORPLY include:
SCANMAIL, SCANPENN, SCANSTATES, SCANYORK (AMERICAN SCANTIC LINE)

Installations of FLEXWOOD include:
U.S.S. TUSCALOOSA—OFFICERS' WARDROOM
EARL CARROLL'S YACHT

Excepting for the fact that waterproof glue has invariably been used on all of these panels, the type of construction which we have used is varied. Most of the bulkhead panels for staterooms have been made with a White Pine core for light weight and faced with Birch or Gum to provide a hard surface which will take a smooth paint job. In public spaces where the panels are large and exotic woods in design are frequently used, the construction has been a Chestnut lumber core with Poplar crossbanding. Panels in size up to 4′ x 10′ have been delivered depending of course upon the deck height. In the millions of feet of Plywood which we have delivered to the principal shipbuilders of the United States, we have had no failure of this product which has heretofore been glued with Casein glue but is now being glued with the resin process because of its vast superiority.

Diesel Yacht "Arar" COURTESY OF BATH IRON WORKS

Interior of "Arar" PHOTOS BY EDWIN LEVICK



Avodire Crotch

Brazilian Rosewood

Bubinga

COURTESY, "AMERICAN ARCHITECT"

PLYWOOD IN THE FURNITURE FIELD

Tremendous quantities of Plywood are used in the manufacture of furniture and radio cabinets because of the beauty obtainable in matched veneers and the superior strength and workability of laminated wood. It is interesting to point out that Plywood is more expensive than solid wood. Unfortunately the term "veneers" carries to most people a sense of something cheap or inferior. Actually a good Mahogany Plywood top (usually 13/16" 5-ply) costs more than one of solid Mahogany.

The beautiful appearance of furniture and radio cabinets is obtained by carefully selecting and matching figured woods. Even the hidden parts, drawer bottoms, backs, etc., are made of Plywood because of great strength and freedom from warping, and light weight.

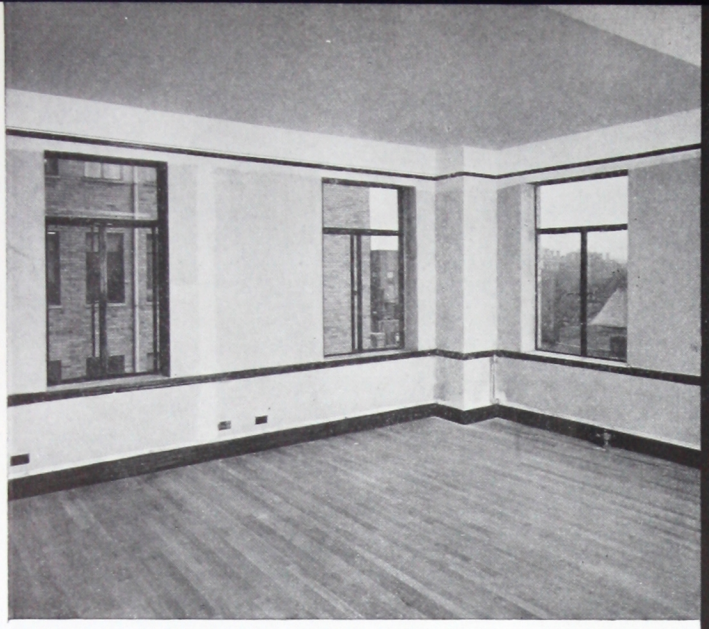
Furniture Plywood is made to order at the mill in exact accordance with the manufacturers' specifications, either flat or curved. It is furnished cut to size, nicely sanded, ready for machining and assembling. Because of our facilities we are in excellent position to handle this type of Plywood.

Curved pew backs and seats are made with heavier Plywood. These are manufactured in special forms under great pressure. So manufactured, they will definitely maintain the desired shape. Many of the standard forms and shapes are available at our mills and can be used without special surcharges. Special forms for modern furniture can be made to order to produce effects similar to the curved walls in the Men's Bar of the Waldorf-Astoria Hotel.

SPECIFYING PLYWOOD

A perusal of this booklet will show that there are many types of Plywood from the very inexpensive for minor and relatively unimportant uses to the highly ornamental or technical Plywood intended for exacting use. On the latter, specification by Plywood manufacturers' name is necessary because of the skill required in performing the intricate processes necessary to a perfect result. Lest this suggestion be misinterpreted, we wish to point out that there are a number of Plywood manufacturers turning out a high-class product, three of whom make a fine resin Plywood such as Weldwood, but as the competitive contractor is not apt to be a judge of fine Plywood, the names of manufacturers should be used and the words "or equal" should be omitted.

The United States Plywood Company, Inc., is the largest organization of its kind. It maintains warehouses from Coast to Coast and has one of the largest and most modern manufacturing plants located at Seattle, Washington, a Flexwood plant at Louisville, Kentucky and co-operating hardwood panel plants in the East and Middle West. It conducts its own fleet of trucks for delivery and has a sales personnel available in any part of the United States.



The office of Patrick J. Hurley in Washington, D. C. showing bare walls before Flexwood installation.

The work of transforming Mr. Hurley's office begins. Photo shows workman hanging Flexwood.

Mr. Hurley's office after Flexwood installation, showing the use of Walnut Flexwood in panelled treatment—a lovely, mellow effect achieved quickly and without extravagance.

Flexwood

Flexwood is genuine wood veneer cut to 1/85 of an inch, glued under heat and hydraulic pressure to cotton sheeting with a waterproof adhesive. A patented flexing operation breaks the cellular unity of the wood to produce a limp, pliable sheet which may be applied by hand to any smooth surface, flat or curved. Waterproof Flexwood cement, which makes a permanent bond, is used to apply Flexwood. Standard sizes of stock material are 18 inches and 24 inches wide and eight foot and ten foot lengths.

Dry plaster, steel, Fir plywood, hard wallboards, tile, marble, asbestos, glass, etc., make perfect backgrounds for Flexwood treatment. Sheets may be hung horizontally or vertically for modern sheer wall treatments or for Georgian or classical panel designs. Inlays and murals are produced by combining various woods.

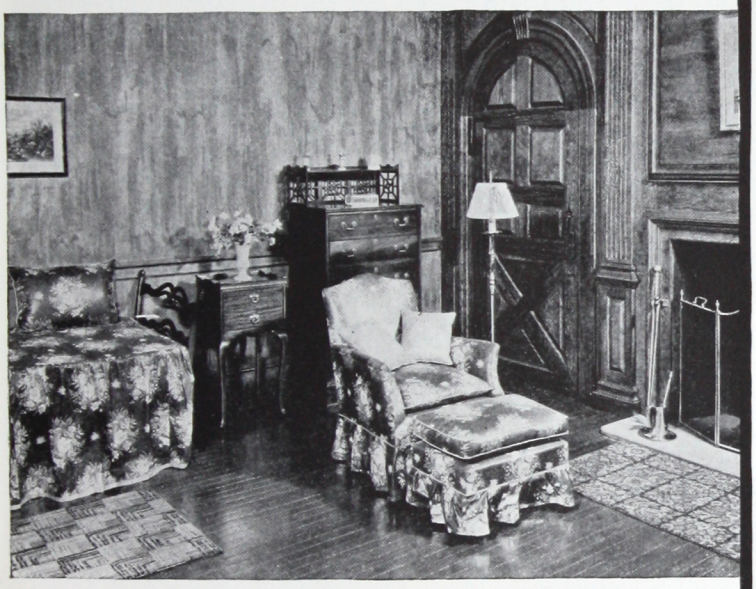
Columns, round or square, can be completely wrapped with Flexwood. Sharp corners and fluted pilasters are treated as easily as plane surfaces.

THE MECHANICS OF INSTALLATION

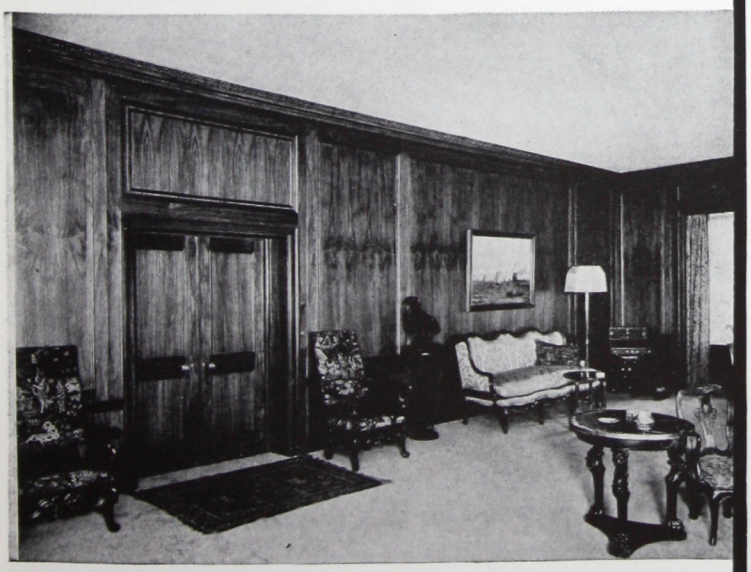
Mechanically, Flexwood is very simply installed. The background is sized with Flexwood cement. Another coating of cement is brushed on the Flexwood which is then hung in the manner of any sheet wall covering.

A stiff broadknife, used with considerable pressure, smooths out the Flexwood, removes air spaces and furnishes the necessary contact. Any skilled paperhanger can do a perfect job by following printed instructions. Flexwood, because it is wood, takes any wood finish.

In this typical office installation a strikingly beautiful effect was obtained with Half-round Walnut Flexwood in Georgian panel design.



This charming Colonial bedroom uses Knotty Pine Flexwood to achieve its cosy luxury.



A handsome living-room with matched Walnut Flexwood panels in an apartment high above New York in the new Waldorf-Astoria Towers.

HOW FLEXWOOD MAY BE USED

Flexwood in the hands of the designer is a tool as essential as metal, paint or glass for creating modern effects. Its uses are limited only by the ingenuity of the designer.

Flexwood treatment is not to be confused with any other means of creating wood interiors. Instead of taking the place of cabinet work, the two are frequently combined by using Flexwood for curved surfaces, wrapped columns, etc., and Plywood for the panelled sections. In many cases flush treatment can only be accomplished with Flexwood and its definite economy when used in this manner makes it possible to create a wood interior for little more than the cost of a paint or paper treatment.

The definite economy of Flexwood is particularly emphasized when it is used in buildings governed by city fire ordinances.

WOODS AVAILABLE

Rare and exotic woods from all corners of the earth are available in Flexwood, making it possible to create and execute distinctive interiors in from 25-50% of the time normally required. Wood selections can be made from actual flitch samples. Some of the woods available are:

Mahogany	Harewood
Walnut	Macassar Ebony
Oak	Tamo
Prima Vera	Rosewood
Redwood Burl	Butt Walnut
Knotty Pine	English Oak
Orientalwood	Maple
Satinwood	Avodire
Zebrawood	Lacewood
Claro Walnut	Crotch Mahogany

Flexwood meets every decorative requirement in the field of homes, offices and institutions. When the luxury obtainable only with genuine wood treatment is desired and economy and time are imperative, Flexwood is the answer.

Decorative
MICARTA

A Modern Material for Interiors and Exteriors

Fascinating things are being done with the new Westinghouse product MICARTA. Technicians describe it as a combination of synthetic resin and paper or fabric.

The designer of furniture and of architectural exteriors or interiors discovers that Micarta is stronger than castiron; that it has 90 per cent of the tensile strength of aluminum yet only half the weight. He finds it resilient and flexible, for application to rounded surfaces; but tougher than a fine hard wood, and even easier to saw or fit into place, because it has no "grain" and will not split or check. It is not affected by water, oil, dilute mineral acids and alkalies. Heat does not injure it up to 250° F. But, most important of all, its processes of manufacture give it a glass-smooth finish in any color or design, making it ideal for interesting effects in the finest modern spirit.

Although the flexibility of its manufacturing methods permits remarkably natural reproductions of wood, marble, or opaque glass, the finest results with Micarta have been achieved by those who recognized that it was not a "substitute" for any other material, but a new material with its own individual beauties and advantages. With Decorative Micarta available in more than thirty-two standard colors and designs, the basic field of application lies in creating new decorative effects rather than in imitating the old.

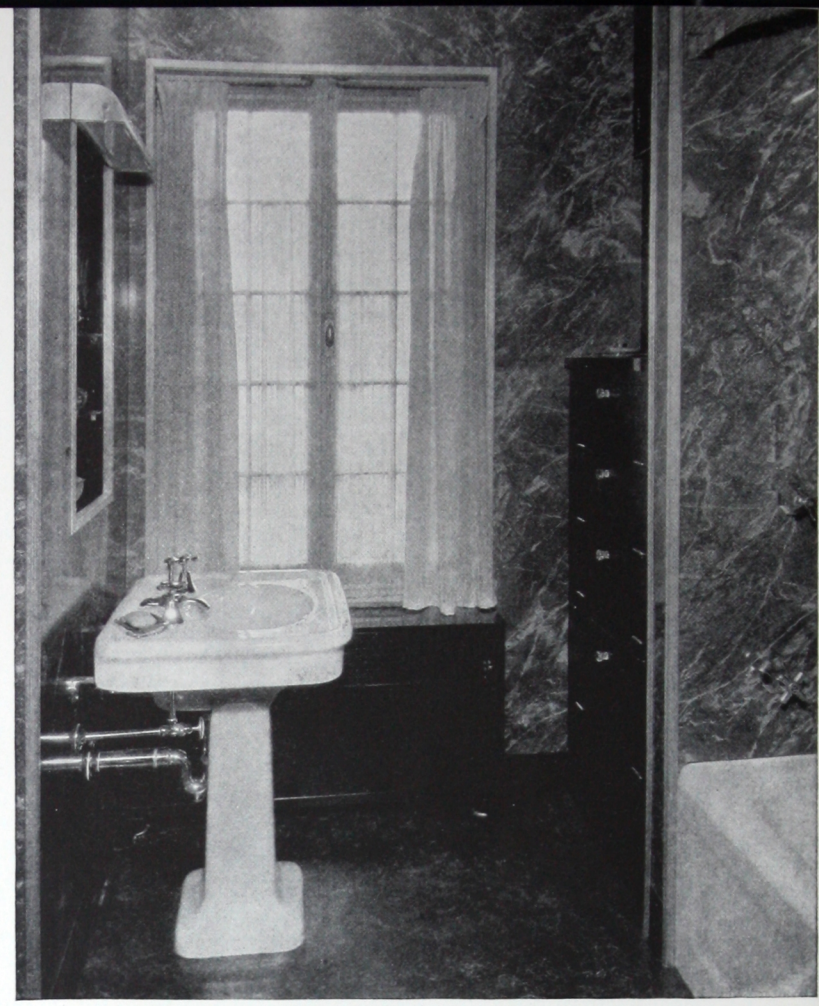
Decorative Micarta is designed for two principal classes of application, veneering and paneling. Furniture, stores and office equipment, wainscoting, ceiling work, bases, chair rails, filler boards, etc. belong to this first classification. For veneering purposes Micarta sheets are supplied in thicknesses of $\frac{1}{16}$ in., $\frac{3}{32}$ in., and $\frac{1}{8}$ in. in standard sizes of 48 in. x 96 in., 36 in. x 72 in., and 48 in. x 48 in. The sheets may be glued or cemented to plywood, wood compositions and metal, or molded to other plastic materials as required.

Paneling applications include construction work of all kinds, such as wainscoting and partitions. In the case of certain colors and kinds of Micarta it includes store fronts, signs and other exterior work. In ship-building and airplane construction both the sheet and panel have been used successfully. For paneling applications Micarta is supplied in three forms: Micarta Preswood, $\frac{5}{32}$ in. and $\frac{9}{32}$ in. thick; Micarta Wemcore (a specially-treated core material developed and used by Westinghouse) $\frac{5}{32}$ in., $\frac{1}{4}$ in. and $\frac{11}{16}$ in. thick; and Micarta Asbestos $\frac{1}{4}$ in. and $\frac{7}{16}$ in. thick.

Micarta is less expensive than most other materials commonly used for table tops, soda fountains and bars. It compares in first cost with the best grades of wood veneer, but because it will never need refinishing it actually costs less than wood in the long run. The application of Micarta to Plywood, and other surfaces is simple and can be done successfully by any furniture or fixture manufacturer or cabinet maker.

Compared with other materials that have been used for kitchen and bathroom walls, Micarta has many distinct advantages. Usually, these rooms are subjected to moist, steamy, atmosphere that very quickly destroys the finish and appearance of most materials. Micarta stands up under these conditions. It retains its lustre, color, and new appearance.

Micarta is especially valuable in remodeling and modernization work. It is easy to apply to plastered walls and can be cut and fitted with ordinary tools.

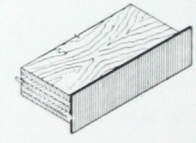


Micarta bathroom at the home of Mr. G. J. Pettits, Peekskill, New York.

★ OPERATIONS IN MICARTA VENEERING

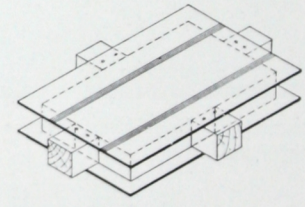
FOR MANUFACTURING TABLE TOPS, BARS, COUNTERS, ETC.

NOTE: INLAY PLATE TO BE VENEERED SHOULD BE ONE INCH LONGER EACH DIMENSION.

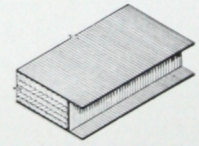


FIRST STEP
GLUING EDGE STRIPS

EDGE STRIPS GLUED TO EXTEND APPROX. 1/16" ABOVE AND BELOW FACE OF CORE. WHEN DRY, PLANE FLUSH.

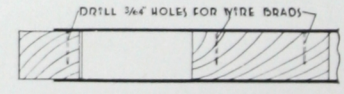


INLAY SHEETS OF MICARTA HELD IN ALIGNMENT BY USE OF WOOD BLOCKS.

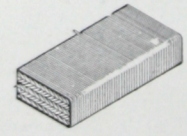


SECOND STEP
GLUING TOP AND BOTTOM SHEETS

CUT MICARTA SHEETS 1/2" OVERSIZE TO GIVE APPROX. 1/4" OVERHANG ON ALL EDGES TO TAKE CARE OF SLIPPAGE IN GLUING.

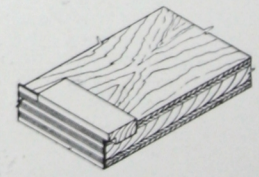


DETAIL SHOWING BLOCKS HOLDING MICARTA IN PLACE

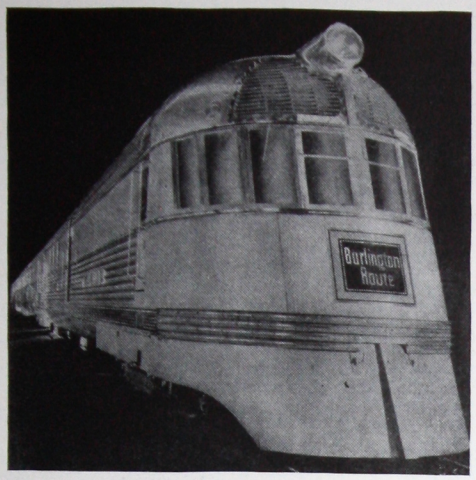


THIRD STEP
FINISHING

DRESS TOP AND BOTTOM SHEETS FLUSH WITH EDGE STRIPS ADDING SLIGHT BEVEL. USE SHAPER OR HANDPLANE AND FINISH WITH FILE AND SANDPAPER.



RABBETED WOOD STRIP USED AS STOP AND GUIDE WHEN GLUING EDGE STRIPS WITH HORIZONTAL INLAY.



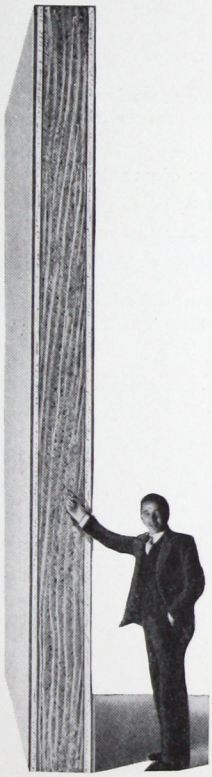
The "Mark Twain." Latest of the Burlington Zephyrs. Stainless Steel Armorply deadlight (upper outside) panels.

ARMORPLY

METAL FACED PLYWOOD—LIGHT YET STRONG STRUCTURAL AND DECORATIVE

To meet the engineering requirements of light weight with maximum strength, ARMORPLY metal-faced Plywood is offered in a number of constructions with various combinations of metal.

ARMORPLY exterior panels as used in the Burlington Zephyrs and similar type high speed trains is a combination of 1/4" Plywood, .0156 18-8 stainless steel and 2-ounce copper. For the panelling of truck bodies in such fleets as the Borden Company, Moran Transportation, Metropolitan Distributors and others, the ARMORPLY used is a combination of 1/4" or 3/8" Plywood with a facing of thin galvanneal steel. This construction is available from stock in many sizes and has many structural applications.



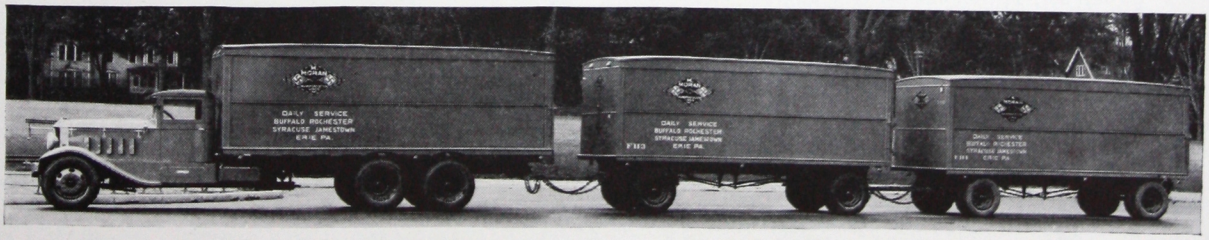
Long before there was official agitation for greater safety at sea ARMORPLY, with its fire-resisting metal face, was being used for protection against fire. For maximum efficiency the Plywood can be fireproofed by impregnation. It is an ideal construction for stateroom partitions.

Manufacturers of fine hospital and restaurant equipment find many uses for ARMORPLY with a facing of Monel Metal, Allegheny steel, stainless steel or chrome plated metals.

For store fixtures there is a special ARMORPLY construction for show case doors. It consists of a steel core with veneer crossbands and selected matched veneer faces. This panel remains perfectly flat and can be used in a 3/8" thickness or less.

Modernization of old elevator cars is simplified by using another special ARMORPLY construction. ARMORPLY of 1/4" thickness, galvanneal faced two sides and weighing only 2.4 lbs. per square foot is generally used. When a wood finish is required, one metal surface is faced with 1/28" veneer of any kind. Panels of 1/2" or 3/4" thickness are sometimes used for doors.

ARMORPLY can be worked with average shop equipment, cut on a band saw, nailed, drilled, routed and bent when necessary.



Part of a fleet of more than 100 Armorply bodies operated by Moran Transportation Co., Buffalo, N. Y.

GLOSSARY OF PLYWOOD TERMS

BACK—The veneer sheet on the underside of a plywood panel, corresponding in thickness, frequently in wood, to the face veneer on the upper or exposed surface.

BURL—A type of figure produced by cutting through burls, which are wartlike protuberances on trees. They contain the dark pith centers of a large number of undeveloped buds.

CHECKS—Small hair-line splits which generally occur only in finely figured crotches and burls, caused chiefly by strain produced in the seasoning.

CORE—The center stock of a plywood panel.

COUNTER FRONTS—Lumber core Plywood, usually twelve feet wide, the face grain of which runs vertically with the short dimension.

CROSS-BANDING—The veneer sheet between the core and the face veneer. Its grain runs at right angles to the grain of the core.

CROTCHWOOD—Highly figured veneer produced from that portion of a tree where two limbs unite.

FACE VENEER—The veneer sheet on the upper side of a plywood panel. Its grain runs parallel to the grain of the core and crosswise to the grain of the cross-banding in 5 ply construction.

FIGURE—Figure is the pattern formed by peculiar or abnormal arrangement of the elements within the tree; by reflected light caused by that arrangement, or by the exposure of the medullary rays.

FLAT GRAIN—Refers to the grain produced in approximately tangential or plain cut veneers.

FLITCH—(a) A hewn or sawed log or a section of a log made ready for cutting into veneers by shaping up the edges, etc. (b) After cutting a complete bundle of thin sheets laid together in sequence as they were sliced or sawn.

GRAIN—A rather loose term applied to the alignment and arrangement of cells and other elements of wood as it occurs in the living tree.

GRAIN CHARACTER—The pattern produced by cutting through growth rings and exposing the layers of springwood (porous) and summerwood (dense) and of prominent vessels, thus producing a varying pattern.

HALF-ROUND—A method of cutting veneer to bring out certain grain character, accomplished in a manner similar to rotary cutting except that the piece being cut is mounted, off center, on a "stay log," a device that permits the cutting of the log on a wider sweep.

HARDWOODS—General term used to designate the lumber produced from broad-leafed or deciduous trees in opposition to the so-called softwoods, those produced by evergreen or coniferous trees.

HEARTWOOD—The inner, matured portion of the tree, darker in color.

KNOTS—Cross section of a branch or limb whose grain usually runs at right angles to that of the piece in which it occurs.

KNOTS, PIN—A knot less than 1/4-inch in diameter which obviously shows a distinct central portion, as distinguished from swirls.

LUMBER CORE CONSTRUCTION—Plywood core a center of narrow edge glued strips of lumber.

PLY—A term that designates the number of layers or laminations of a plywood panel as 3-ply, 5-ply, 7-ply, etc.

QUARTERS—Quartered or striped wood are sheets where quartered grain predominates with little or no heart grain. Quarters are produced by removing the center (or heart grain) from the sheets, or by cutting quartered flitches.

ROTARY CUT—A manner of cutting veneer by which the entire log is mounted centrally in a lathe and turned against a broad cutting knife which is set into the log at a slight angle.

SAPWOOD—The outer living portion of the wood in a tree.

SLICED—A manner of cutting veneer by which logs or sawn flitches are held securely in a slicing machine and passed across a large knife which shears off the veneer in sheets.

STUMPWOOD—Obtained from the base or stump of a tree. Figured stumpwood occurs where the wood fibre is crinkled into wavy ripple marks during the process of growth.

SWIRLS—(a) The small spots developed by irregular grain adjacent to a pin knot, usually where the black center of the pin knot itself does not show, is also described as a swirl or cat eye. These usually are but a fraction of an inch in diameter. (b) Irregular grain, usually surrounding knots or crotches. Small sheets with swirl figure are produced for overlays and small matched panels.

VENEER CONSTRUCTION—Plywood made entirely of Veneers.

AVAILABLE WOODS FOR SPECIAL PLYWOOD NOT CARRIED IN STOCK

NAME	TEXTURE	COLOR	FIGURE	ORIGIN	REMARKS
Acacia	hard	yellow	.....	Near East	
Acle	medium	dark brown	mild	Philippines	
Almique	very hard	reddish brown	mild	Guiana and Cuba	Mostly used for inlay.
Amaranth	very hard	purple	mild to high	Guiana	Other name Purpleheart.
Amboyna Burl	medium	light brown	curly	Guiana	Very beautiful; quite expensive.
Andiroba	hard	brown	stripe	South America	A Ford Co. product.
Apple	medium	light	plain	U. S. A.	Used for inlays and turnery.
Ash (American)	medium	light brown	medium	U. S. A.	
Ash (English)	medium	light	medium	England	Also to be had in burls. Similar in appearance to Olivewood.
Ash (Machine Cut)	medium	light	scalloped	U. S. A.	Cut with wavy knife, producing unique figure.
Ash (Japanese)		SEE TAMO			
Ash (Hungarian)	medium	light tan	brilliant	Hungary	A gorgeously figured wood.
Aspen	medium	light	strong	U. S. A.	Sometimes called Silver Poplar. Can be had in highly figured crotches of large size.
Avodire	medium hard	light yellow	strong	Africa	Carries heavy cross-fire.
Ayous	medium	light yellow	stripe	Africa	Sometimes used in place of White mahogany.
Balsa	very soft	white	none	So. America	The lightest wood in weight; little strength.
Balaustre	hard	orange	medium	So. America	Fine for modernistic work.
Basswood	soft	white	none	U. S. A.	Well behaved light—easily worked.
Beanwood	hard	brown	plain to stripe and curl	Australia	
Beech	hard	pale cherry red	mild	U. S. A. or Europe	Quartered wood—shows small speckle.
Beefwood	very hard	red	mild	British Guiana	For inlays. The violin bow is made of Beefwood.
Bethobara	hard	brown	mild	Guiana	Oily wood not unlike Teak.
Birch	hard	red or white	mild	U. S. A.	Excellent for painting and staining.
Birch (Curly)	hard	red or white	strong	U. S. A.	For unique relatively inexpensive effects—Early American.
Birch (Swedish)	hard	yellow white	gnarled	Sweden	Also known as Alpine burl.
Blackwood	hard	deep red brown	cross figure and mottle	Tasmania	
Bodi	hard	yellowish brown	rope and broken stripe	Africa	
Bosse	hard	light mahogany	good	Africa	
Bubinga	hard	rose	strong	Africa	Sometimes called "Faux Rosewood."
Butternut	medium	yellow gray	like walnut	U. S. A.	
Camagon					
Canary	hard	light yellow with dark streaks	strong	Brazil	
Cedar (Auromatic Red)	soft	red	very strong	U. S. A	Knotty wild figure for closet lining and strong cover effects.
Cedar (Spanish)	medium	red	mild	Africa	Like a very mild mahogany.
Cherry	hard	light red	good	U. S. A.	Genteel close-grained wood.
Chuglum	hard	brown and yellow	plain to broken stripe	India	
Cocobalo	very hard	rose	very highly	Central America	
Cocus	hard	yellow brown with dark streaks	stripe and grain figure	West Indies	Stickwood
Cordia	medium	reddish	stripe	South America	Available only in small quantities.
Cypress Crotch	soft	cream	beautiful	U. S. A.	Also called Faux Satine.
Dao	hard	grayish brown	stripe and mottle	Philippine Islands	
Degame (Lauan Wood)	medium	yellow	mild	Central America	
Ebony (Gaboon)	very hard	brown black	medium	Africa	The blackest ebony.
Ebony (Macassar)	very hard	brown and black	stripe	Dutch East Indies	A rich, warm cabinet wood.
Elm (Carpathian Burl)	medium	coffee	swirl	Africa	Gorgeous figure.
Elm (English)	medium	light coffee	swirl	England	
Eucalyptus	medium	tan	good	U. S. A.	
Florisa	medium	brown	stripe	Central America	On account of gum in the wood it is not a desirable cabinet wood.
Freijo		SAME AS CORDIA			
Goncalo Alves	medium	coffee	very high	South America	
Granadillo		SAME AS COCUS			
Guanacosta	medium	brown	stripe	Central America	
Gurjon	hard	yellowish tan	stripe	India	Used largely for flooring; very little available in this country.
Harewood	medium	white	heavy x-fire	England	English Sycamore.
Harewood (Gray)	medium	silver	heavy x-fire	England	English Sycamore dyed.
Holly (White)	hard	white	meagre	U. S. A.	Fine for inlays.
Holly (Ebonized)	hard	black	meagre	U. S. A.	
Imbuya	hard	brown	high	Brazil	Brazilian Walnut.
Jarrah	hard	bright brick red	stripe	Australia	Very little available.
Jenizero		SAME AS GUANACOSTA			
Kelobra		SAME AS GUANACOSTA			
Kingwood	hard	violet brown streaked with black	brilliant	South America	
Koa	hard				
Koko	hard	dark brown	mild	Burmoli	
Lacewood (Silky Oak)	medium	light brown	small and large flake	Australia	Australian Oak.
Laurel (East Indian)	medium	reddish brown	strong wavy	East Indies	
Locust		.....	.....	West Indies	
Lovea		SAME AS TIGERWOOD; SOMETIMES KNOWN AS AFRICAN WALNUT			
Madrone (Burl)	medium	pink cast	swirl	U. S. A.	
Mahogany (African)	medium	red to red brown	stripe—broken stripe—x-fire	Africa	Carries a large variety of figures, including crotches.
Mahogany (Cuban)	hard	light red	mild—beautiful	Cuba	
Mahogany (Mexican)	hard	red	mild	Mexico	
Mahogany (Philippine)	medium	red	medium	Philippine	
Mahogany (San Domingo)	hard	red	good	San Domingo	
Mahogany (Sapele)	hard	red	narrow stripe	.....	Excellent for diamond matching.
Maidou Burl	medium	red	very strong		
Majagua	hard	greenish gray	light and dark streaks	West Indies	
Mansonia	hard	walnut brown	plain to stripe	Africa	A good substitute for walnut where very long lengths are required.
Maple	very hard	white	mild	U. S. A.	
Maple (Birdseye)	very hard	white	high	U. S. A.	With well-known Birdseye figure.
Maple (Curly)	very hard	white	curly	U. S. A.	
Maple (Quilted)	medium	white	cloud like	U. S. A.	Fleecy, cloud-like figure.
Maple (Australian)	hard	light red	deep	Australia	A beautiful unique refined deep wood.
Maple (Burls)	hard	red	swirly	U. S. A.	
Maple (Australian Butts)	hard	light red	high	Australia	
Marnut					
Marupa	soft	white	plain	South America	None available commercially.
Mausonia					
Myrtle Burl	medium	red	heavy swirl	U. S. A.	California Redwood.
Narra	hard	yellow and red	stripe and grain	Philippine Islands	

AVAILABLE WOODS FOR SPECIAL PLYWOOD NOT CARRIED IN STOCK (continued)

NAME	TEXTURE	COLOR	FIGURE	ORIGIN	REMARKS
Oak	medium	tan	varied	U. S. A.	Red, white, plain and quartered.
Oak (English)	hard	brown	deep subdued	England	Finest cabinet wood and most distinguished; "Pollard Oak."
Oak (Tasmanian)	hard	brown	wild	Tasmania	Known as Yuba.
Olivewood	hard	light	good	Italy	
Orientalwood	medium	light brown	pronounced x-fire	Australia	Sometimes called Oriental Walnut.
Padouk	hard	blood red	uniform	Africa	Also known as Corail and Vermillion.
Pearwood	soft	yellowish red	good	Europe	
Peroba	hard	rose	mild	Brazil	
Pine (White)	soft	white	mild	Idaho (U. S. A.)	
Pine (Knotty)	soft	white	selected knots	U. S. A.	
Pine (California)	soft	yellow white	medium	California	Usually rotary cut for paint work.
Poon	hard	pinkish	plain	India	Practically none available commercially.
Poplar (Whitewood)	soft	yellow	none	U. S. A.	For painting and staining.
Prima Vera (White Mahogany)	medium	yellow white	stripe and x-fire	Central America	Rich satinlike wood.
Purpleheart		SEE AMARANTH			
Redwood Burl	soft	deep red	intricate swirl	California	
Rose Laurel	hard	tan	mottle	Australia	
Rosemay	hard	pinkish	grain figure	Australia	Little available commercially.
Rose Pamel					
Rosewood (Brazil)	hard	dark red	high flower—dark and light	Brazil	Usually cut rotary or half-round, producing beautiful effects.
Rosewood (East Indian)	hard	straw—to dark red	stripe	East Indies	
Rosewood (Honduras)	hard	medium red	high flower	Honduras	Lighter in color than other Rosewood.
Sabicu	hard	brown	mottle, stripe and grain	West Indies	
Samba	soft	cream gray	stripe	Africa	
Santa Maria	medium	pinkish	plain	Central America	Used particularly for drawer bottoms; not a high class cabinet wood.
Faux Satine	soft	light yellow	very pronounced	U. S. A.	Cypress Crotch.
Satima (French)	hard	red brown	mild	France	
Satinwood (Brazil)	hard	light yellow	stripe and cross-fire	Brazil	
Satinwood (East Indian)	hard	light yellow	stripe and flower	East Indies	The true Satinwood.
Sequoia (Redwood)	soft	red	pronounced	U. S. A.	
Sisso	hard	yellowish brown	stripe and mottle	India	
Spruce (Knotty)	soft	yellow	branch and round knots	U. S. A.	Simulates English Deal.
Sycamore (U. S. A.)	medium	light brown	interesting flake	U. S. A.	
Sycamore (English)	medium	white	heavy cross-fire	England	Harewood undyed.
Taku	hard	brown	stripe and mottle	South America	
Tamo (Japanese Ash)	medium	tan	swirl and peanut	Japan	A gorgeous lively wood.
Teak (Java)	hard	warm brown	mild to medium	Java	
Teak (Rangoon)	hard	warm brown	mild to medium	Africa	
Thitka	hard	mahogany	stripe and mottle	India	
Thuya Burl	medium	rich red brown	curly swirl	French Africa	
Tigerwood	hard	light brown	narrow stripe	Africa	Sometimes called African Walnut.
Tulipwood	hard	light streaked	light, streaked with red and yellow		
Walnut	hard	brown	highly varied	U. S. A.	Obtainable in stripe-heart burls and crotches in wide variety.
Walnut (Brazil)	hard	deep brown	pronounced	Brazil	Also known as Imbuya.
Walnut (Circassion)	hard	light brown and black	strikingly strong light brown with black	Asia	One of the very fine cabinet woods.
Walnut (Italian)	hard	light brown	stripe	Italy	Somewhat lighter in tone than American Walnut.
Walnut (French)	hard	light brown	stripe	France	Similar to Italian.
Warri	hard	tan	stripe, butt and mottle	Australia	
Whitewood		SEE POPLAR			
Yuba	hard	brown	oak type strong x-fire	Tasmania	Also called Tasmanian Oak.
Zebra	hard	black and tan	like Zebra skin	Africa	Used frequently for modernistic work

PLYWOOD CARRIED IN STOCK

NAME	TEXTURE	COLOR	FIGURE	REMARKS
Ailon	hard	white	mild	Extremely smooth surface.
Basswood	soft	white	unfigured	
Birch	hard	white or red	mild figure	
Cedar	soft	bright red	highly figured	aromatic
Chestnut	soft	brown	highly figured	
Duali	hard	light tan	medium figure	Excellent; inexpensive.
Fir	medium	yellow	wild figure	Inexpensive
Gum (Plain)	medium hard	reddish brown to white	mild figure	
Gum (Figured)	medium hard	reddish brown	very highly figured	Cabinet wood.
(Orientalwood)	hard	light brown	highly figured; stripe or cross-fire	
Mahogany (African)	hard	red	(carried in) stripe, broken stripe, plain and cross-fire	
Maple	hard	white	(carried in) birdseye, curly, unselected and plain white	
Oak	hard	tan	(carried in) quartered large flake or mild figure, plain sawn and rotary cut	
Pine (California White)	soft	yellow—white		Excellent painting surface; easily worked—inexpensive.
Pine (Knotty Idaho)	soft	white	carrying small well distributed sound knots	
Poplar (Whitewood)	soft	yellow	unfigured	
Prima-Vera (White Mahogany)	medium hard		stripe figure	
Walnut (American black)	hard	light to dark brown	(carried in) stripe-heart, stripe and cross-fire figures	
Walnut (Circassion)	hard	light brown and black	highly figured	

STRENGTH OF VARIOUS SPECIES OF 3-PLY PANELS

All plies in any one panel of the same thickness and of the same species; grain of successive plies at right angles. All material rotary cut. Vegetable glue used throughout. Eight thicknesses of plywood, ranging from 3/30" to 3/6", were tested.

Species.	Average specific gravity of plywood based on oven-dry weight and volume at test.	Column-bending modulus.				Tensile strength.				Modulus of elasticity.	
		Parallel.*		Perpendicular.*		Parallel.*		Perpendicular.*		Parallel (1,000 pounds per square inch).*	Perpendicular (1,000 pounds per square inch).
		Number of tests.	Pounds per square inch.	Number of tests.	Pounds per square inch.	Number of tests.	Pounds per square inch.	Number of tests.	Pounds per square inch.		
Ash, black	0.49	120	7,760	120	1,779	120	6,180	120	3,940	1,073	96
Ash, commercial white	.60	200	9,930	200	2,620	200	6,510	200	4,350	1,420	143
Basswood	.42	200	7,120	200	1,670	200	6,880	200	4,300	1,213	85
Beech	.67	120	15,390	120	2,950	120	13,000	120	7,290	2,149	167
Birch, yellow	.67	195	16,000	200	3,200	200	13,200	200	7,700	2,259	197
Cedar, Spanish	.41	115	6,460	115	1,480	115	5,200	115	3,340	1,032	84
Cherry†	.56	115	12,260	115	2,620	115	8,460	115	5,920	1,627	152
Chestnut	.43	40	5,160	40	1,110	40	4,430	40	2,600	744	75
Cottonwood	.46	120	8,460	120	1,870	120	7,280	120	4,240	1,437	109
Cypress, bald	.47	35	7,830	35	1,820	35	6,560	35	4,390	1,144	91
Douglas fir	.49	150	9,460	174	1,950	174	6,230	174	4,000	1,566	129
Elm, cork	.62	65	12,710	65	2,500	65	8,440	65	5,500	1,982	136
Elm, white	.52	160	8,680	160	1,970	160	5,860	160	3,990	1,224	109
Gum, black	.54	40	8,090	40	1,920	35	6,960	35	4,320	1,275	113
Gum, cotton	.50	80	7,760	80	1,580	80	6,260	80	3,760	1,300	111
Gum, red	.54	182	9,970	182	2,070	182	7,850	182	4,930	1,592	120
Hackberry	.54	80	8,100	80	1,880	80	6,920	80	4,020	1,154	99
Hemlock, western	.47	119	9,250	119	1,960	119	6,800	119	4,580	1,581	112
Magnolia‡	.59	40	9,830	40	2,340	40	10,000	40	5,740	1,704	135
Mahogany, African§	.52	20	8,070	20	2,000	20	5,370	20	3,770	1,261	144
Mahogany, Philippine△	.53	25	10,160	25	2,310	25	10,670	25	5,990	1,820	169
Mahogany, true	.48	35	8,500	35	1,940	35	6,390	35	3,780	1,252	117
Maple, soft•	.57	120	11,540	120	2,420	120	8,180	120	5,380	1,752	145
Maple, sugar	.68	202	15,600	202	3,340	192	10,190	202	6,530	2,112	189
Oak, commercial red	.59	115	8,500	115	2,070	115	5,480	115	3,610	1,289	120
Oak, commercial white	.64	195	10,490	195	2,310	195	6,730	195	4,200	1,343	118
Pine, white	.43	35	7,920	40	1,770	40	5,640	40	3,870	1,274	99
Poplar, yellow	.50	165	8,860	165	1,920	165	7,390	165	4,720	1,544	115
Redwood	.41	65	7,900	65	1,500	65	5,100	65	3,000	1,211	118
Spruce, Sitka	.43	103	7,640	103	1,689	103	5,600	103	3,250	1,395	105
Sycamore	.56	163	11,040	163	2,340	163	8,030	163	5,220	1,628	130
Walnut, black	.59	110	12,660	110	2,770	110	8,250	110	5,260	1,736	141

* Parallel and perpendicular refer to the direction of the grain of the faces relative to the direction of the application of the force.
† Probably black cherry. ‡ Probably evergreen magnolia. § Probably khaya sp. △ Probably tanguile. • Probably silver maple.

ADVANTAGES OF PLYWOOD OVER OTHER WALL MATERIALS

1. High Crushing Strength.
2. Resistance to Surface Damage or Gouging.
3. Ease of Repair of Surface Damage. (Sand It Out and Refinish.)
4. Cuts Easily and Cleanly With Common Tools.
5. Holds Nails Close to Edge—No Breaking or Splitting.
6. Comes in a Variety of Sizes.
7. Offers Variety in Final Finish.
   - *a. Natural wood*
     - *1. Stain and Wax*
     - *2. Stain, Shellac and Wax*
     - *3. Stain and Varnish*
   - *b. Paint Surfaces*
     - *1. Paint directly over wood*
     - *2. Paint over sand finish*
8. Low Maintenance Cost (Permanency).
9. Inherent Beauty of Wood.
10. Is the Strongest Known Material per Unit of Weight.

PLASTER

Is expensive
Sloppy to erect
Slow in building
Damages building through water
Hard to dry out
Moisture danger if not dried out
Easily damaged

SUGAR CANE BOARD

Lacks structural strength
Lacks nailing strength
Rough and absorbent surfaces
Hard to paint
Too rough for paper

GYPSUM BOARD

Lacks structural strength
Lacks nailing strength
Does not saw and work well or easily

TESTS ON DOUGLAS FIR PLYWOOD

Some materials sometimes used instead of Plywood were subjected to exactly the same tests—under exactly similar conditions. In fairness, letters instead of trade names have been used to designate these five materials. A and B are fiber insulating boards; C is a plaster board; D is a hard-compressed fiber board; and E is one of the old-style fiber wallboards.

A number of samples of each of these materials—and of Douglas Fir Plywood—were subjected to each of the following tests, to establish an average strength value that would be eminently fair.

The average moisture content of the Douglas Fir Plywood samples tested was 10%.

All these tests were made by the Northwest Testing Laboratory, which in the Northwest represents the nationally known Pittsburgh Testing Laboratory. A complete log of any test sent upon request.

COMPRESSION TESTS

Two series of tests were made on Douglas Fir Plywood. In the first series the load acted parallel with the grain of the outside plies. In the second series the load acted across the grain of the outside plies. Only one series of tests was necessary on the other materials, because their grain or fiber did not run in different directions. All compression test pieces were cut exactly 6 x 6 inches and bearing was obtained by placing the pieces in the testing machine and applying the load on the opposite edge.

HEAT CONDUCTIVITY OF DOUGLAS FIR PLYWOOD

Thickness	Heat-conducting value
Inch	B.t.u. per sq. ft. per degree F. per hour
1/4	3.0
3/8	2.0
1/2	1.5
3/4	1.0

TENSILE TESTS ON DOUGLAS FIR PLYWOOD

Dimension of Test Specimen			Area, sq. in.	Ultimate load, lbs.	Load, lbs., sq. in.
Thickness	Width, in.	Lgth., in.			
Load Acting with the Grain of Outside Plies					
3/4", 5-ply	3	18	2.250	8912	4074
5/8", 5-ply	3	18	1.875	8132	4350
1/2", 5-ply	3	18	1.500	8024	5135
3/8", 3-ply	3	18	1.125	5644	4750
1/4", 3-ply	3	18	0.750	5250	6484
5/16", 3-ply	3	18	0.562	4176	7901
Load Acting Across the Grain of Outside Plies					
3/4", 5-ply	3	18	2.250	8796	3932
5/8", 5-ply	3	18	1.875	8326	4491
1/2", 5-ply	3	18	1.500	7664	5108
3/8", 3-ply	3	18	1.125	4684	4141
1/4", 3-ply	3	18	0.750	2552	3291
5/16", 3-ply	3	18	0.562	1622	3016
TENSILE TESTS ON OTHER MATERIALS					
A .500	3	18	1.50	370	248
B .4375	3	18	1.20	152	126
C .250	3	18	.75	264	352
D .195	3	18	.585	1276	2180
E .190	3	18	.570	1248	2189

KEY: Materials A and B are fiber insulating boards. C is a plaster board. D is a hard-compressed fiber board. E is an old-style fiber wallboard.

TENSILE TESTS

Specimens in these tests were cut 3 inches wide and 18 inches long, and the distance allowed between the jaws of the testing machine was 8 inches.

As in the compression tests, two series of tests were made on the Douglas Fir Plywood, in one the load acting parallel with the grain of the outside plies, and in the other, across the grain of the outside plies.

COMPRESSION TESTS ON DOUGLAS FIR PLYWOOD

Dimension of Test Specimen			Area, sq. in.	Ultimate load, lbs.	Load, lbs., sq. in.
Thickness	Width, in.	Lgth., in.			
Load Acting with the Grain of Outside Plies					
3/4", 5-ply	6	6	4.50	18538	4186
5/8", 5-ply	6	6	3.75	10644	2893
1/2", 5-ply	6	6	3.00	10492	3497
3/8", 3-ply	6	6	2.25	6630	2860
1/4", 3-ply	6	6	1.50	4198	2855
5/16", 3-ply	6	6	1.125	2014	1917
Load Acting Across the Grain of Outside Plies					
3/4", 5-ply	6	6	4.50	15262	3436
5/8", 5-ply	6	6	3.75	9096	2472
1/2", 5-ply	6	6	3.00	6462	2162
3/8", 3-ply	6	6	2.25	5206	2180
1/4", 3-ply	6	6	1.50	908	609
5/16", 3-ply	6	6	1.125	380	360
COMPRESSION TESTS ON OTHER MATERIALS					
A .500	6	6	3.0	690	230
B .4375	6	6	2.625	448	170
C .25	6	6	1.50	826	550
D .1875	6	6	1.125	846	751
E .1875	6	6	1.125	390	346

KEY: Materials A and B are fiber insulating boards. C is a plaster board. D is a hard-compressed fiber board. E is an old-style fiber wallboard.

TRANSVERSE TESTS ON DOUGLAS FIR PLYWOOD

Dimension of Test Specimen			Ultimate load, lbs.	Deflection ultimate load, in.
Thickness	Width, in.	Length, in.		
Load Acting Across the Grain of Outside Plies				
3/4", 5-ply	6	18	1336	.43
5/8", 5-ply	6	18	696	.42
1/2", 5-ply	6	18	702	.53
3/8", 3-ply	6	18	434	.51
1/4", 3-ply	6	18	220	.76
5/16", 3-ply	6	18	214	1.10
Load Acting with the Grain of Outside Plies				
3/4", 5-ply	6	18	1112	.57
5/8", 5-ply	6	18	758	.53
1/2", 5-ply	6	18	388	.92
3/8", 3-ply	6	18	147	1.36
1/4", 3-ply	6	18	50	1.84
TRANSVERSE TESTS ON OTHER MATERIALS				
A 1/2"	6	18	27	.66
B 5/16"	6	18	15	—
C 1/4"	6	18	42	.61
D 5/16"	6	18	51	.92
E 5/16"	6	18	31	.95

KEY: Materials A and B are fiber insulating boards. C is a plaster board. D is a hard-compressed fiber board. E is an old-style fiber wallboard.

TRANSVERSE TESTS

Here again two series of tests were made on the Douglas Fir Plywood, one in which the load acted parallel with the direction of the grain of the outside plies and another in which the load acted across the grain of the outside plies.

All test pieces were 6 inches wide and 18 inches long. They were placed on supports 12 inches on centers, and the load was applied at midspan.

FOREST PRODUCTS LABORATORY

PREFABRICATION SYSTEM

A NEW DEPARTURE IN ALL-WOOD HOUSING

By

GEORGE W. TRAYER, Senior Engineer

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE
In cooperation with the University of Wisconsin

Since its first demonstration at Madison, Wis., when it attracted thousands of visitors, the U. S. Forest Products Laboratory's prefabricated all-wood house system has drawn many inquiries as to whether it was on the market, what it cost, and how it was made.

From the outset the Laboratory made it clear that the demonstration house it built and exhibited represents a system under development, and not a commercial proposition. Nevertheless, the wide interest registered from both public and trade sources warrants further description of the system at this stage for evaluation of its possibilities from a service and manufacturing point of view.

It is well to point out, as a preface to such a description, that this house, aside from the plywood in its panels, uses about 5,400 board feet of lumber of various kinds. All lumber, moreover, is used economically because of the system of prefabrication employed. Resultant reductions in cost of building, if this type of housing goes eventually on the market, should aid in its widespread adoption and consequently benefit the entire lumber industry.

That its scheme of assembly is well adapted to the requirement of speed in construction is attested by the Laboratory's experience with it. Figures 1 and 2 graphically demonstrate the rapidity of assembly possible. The house was erected complete in 21 hours by seven men.

UTILIZES BUILT-UP WOOD PANEL

Like all prefabricated housing systems either under development or already on the market, the Laboratory has as its basic structural unit a panel. Each panel consists of two plywood faces glued to either side of an inner structural framework to form what is virtually a box girder. The stressed covering principle on which it is built gives it the strength essential for high class construction.

Contrasted with ordinary frame construction, stressed covering opens up a new range of strength and rigidity values with a minimum of material. In the usual floor, for example, subfloor and floor are nailed to relatively deep joists. While the subfloor when laid diagonally stiffens the building to some extent, it contributes little to the strength of the underlying framework. Similarly, ceilings hung on floor joists are additional dead weight.

In the Laboratory's panel, stressed covering incorporates into a single unit joists, sub-

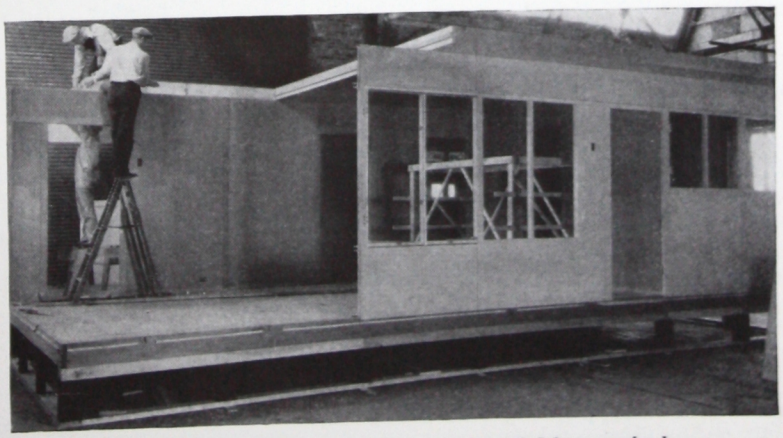


Figure 1.—After 5½ hours this much of the house had been completed.

Figure 2.—Twenty-one hours from the time construction was begun the finished house looked like this.

floor, and ceiling. Weight upon the floor is distributed through the joists to the plywood faces, so that the joists actually support only about one-fourth of the load. This unity of action is due to the complete and continuous rigid joint formed by the glue between plywood faces and joists. Such a joint cannot be produced by nailing.

In like manner wall panels were made up of plywood glued to studding or strips. Wall panels for the demonstration house were built 4 feet by 8 feet of ¼-inch 3-ply plywood glued on ¾ by 1⅜-inch strips, which gives a total wall thickness of 1⅞ inches. The 1⅜-inch strips were chosen to conform with the thickness of light stock doors. Top and bottom members of the panel framework were set in ¾ inch and the outside vertical members the same distance from the edges of the plywood faces, in order to provide the structural joints which will be described.

Floor and roof panels also were built 4 feet wide in conformity with the regular mill width of plywood, and their length in the demonstration house varies from 8 to 14 feet. Because of the strength inherent in this stressed covering type of panel a 2 by 6-inch structural member can be substituted for the usual 2 by 10-inch joist in conventional house construction. The upper face consists of ⅝-inch plywood in five plies, and the lower of ⅜-inch 3-ply stock. Within floor and roof panels a blanket insulator was attached as shown.

Floor panels of this type were tested and found capable of sustaining maximum loads of 300 or more pounds per square foot over a 13 foot 6 inch span. Similarly, wall panels under the pressure of a 60-mile per hour gale would develop a fiber stress in the plywood less than one-third the allowable safe stress for the material.

MULLIONS CONNECT WALL PANELS

Vertical mullions built up of three pieces glued together are used to connect wall panels. Into parallel grooves of the mullions are fitted the plywood edges of adjacent panels. To protect the plywood edges from moisture and to prevent air infiltration, the grooves are coated with a mastic before the panels are shoved home. Bottom projecting edges of the panel fit over a rabbeted sill member for connection between wall and sill, and similarly the top edges receive a ¾-inch by 1⅜-inch member glued to roof panels along wall and partition lines.

Lateral edges of floor and roof panels are grooved to permit a spline connection for the distribution of weight to adjacent panels. A window system with sash larger than the opening, so that the window is hung outside the plane of the casing, was used. Head jambs and sill are completely assembled on the typical window panels, with hinges attached, ready to receive the sash. The closure between sash and casing is sealed with a spring bronze weather strip. A wooden drip cap provides protection at the head.

Finished hardwood floors were laid in sections 4 feet square connected by T-shaped strips screwed to the subfloor, with the flanges of the T holding the squares down. Gum flooring was used in the bedrooms and oak in the living room. A special wood plastic developed by the Laboratory was used for the bathroom floor.

The structure as erected includes all the combinations of panels which might obtain in even a large house, so that the connection problems and the necessary variations in panels could be studied in full scale.

A simple electric wiring plan was adopted for the demonstration house. Under a water table built around the outer base of the house a conduit was attached which supplies

all wiring for exterior wall panels. Into each panel the necessary connections were inserted before assembly. To supply wiring to inside partitions conduits were run underneath the floor panels. Connections for power appliances, radio, and telephone were similarly installed in panels before assembly.

Where the panels would be pierced by conduits or pipes they were reinforced by glued-in blocks.

A considerably higher degree of insulating efficiency is obtainable with this type of panel, which is filled with loose insulation material, than with frame construction consisting of wood siding, wood sheathing, and lath and plaster interior. The plywood

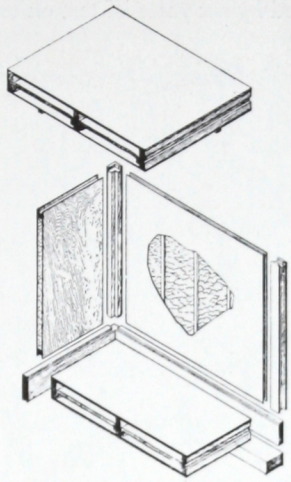


Figure 3.—A standard assembly method for wall, floor and roof panels with a corner mullion and standard mullion. Cut-away views show insulation on place.

panel is about equal to the above type of frame construction with ½-inch flexible insulation added, but would be superior as regards air infiltration.

The roof and floor panels of the type used, including ½-inch flexible insulation, are far superior in insulating value to many common types of floors and roofs.

Because this house was built merely to demonstrate a new idea in prefabrication, it was placed upon a timber foundation. A concrete, stone, or concrete-block foundation could readily be installed beneath it with such additional features as basement furnace room and utility room. The demonstration house was, however, erected with hot-air heating unit in the living room and with a utility room between kitchen and bathroom for economy in installing plumbing fixtures and other appliances.

The plan of the house includes a living room, two bedrooms, kitchen, bath and utility room, all in the space of 21 by 29 feet. Built-in features include a coat closet which screens the front entrance from the living room; a simple vanity and clothes closet in the master bedroom; a clothes closet in other bedroom; and essential cabinets in the kitchen, all made of lumber and plywood. These features are only incidental to the structural system and could be replaced by a wide variety of movables. In figure 4 is shown the floor and room arrangement, together with all equipment and fixtures provided. To present an appropriate and attractive interior, the demonstration home was furnished in modern style within the limitations of a moderate budget.

TECHNICAL PRODUCTION REQUIREMENTS

Behind all systems of house prefabrication, whether in wood, steel, or other materials, lies the same general idea—namely, to put the difficult, intricate part of the work inside the factory, thus reducing the time and expense of assembly on the site to a minimum and providing masses of the population with acceptable housing at a price within their reach. As one writer puts it, the objective is "to make home ownership as common in America as automobile ownership is today."

The footage of dimension material as well as plywood involved in a program of several hundred thousand four-to-six-room houses of the type here considered forms indeed an interesting prospect. But the point should not be overlooked that mass ownership of such things as automobiles today hinges not alone on cheap mass production but on all of that plus increasing precision control in manufacture. Accuracy of fitted parts means real performance, satisfaction in use, fundamental desirability, the difference between success and failure.

The degree to which the woodworking factory can meet close tolerances in moisture condition and machining of the wood, can satisfy exact requirements in gluing, and can insure adequate provision against long-time weathering will determine whether the prefabricated all-wood house is to be a modern reality or just another experiment.

The Forest Products Laboratory believes that, with the start that has been made, all such problems can be mastered. Its own machines have produced panels and mullions that fit and that show no cumulative error of dimension as one part follows the other in enclosing the house. The material has been seasoned and conditioned in accord with the best technical rules and practice, and the method of painting, with two aluminum priming coats, has been verified by six years of test on experimental paint fences.

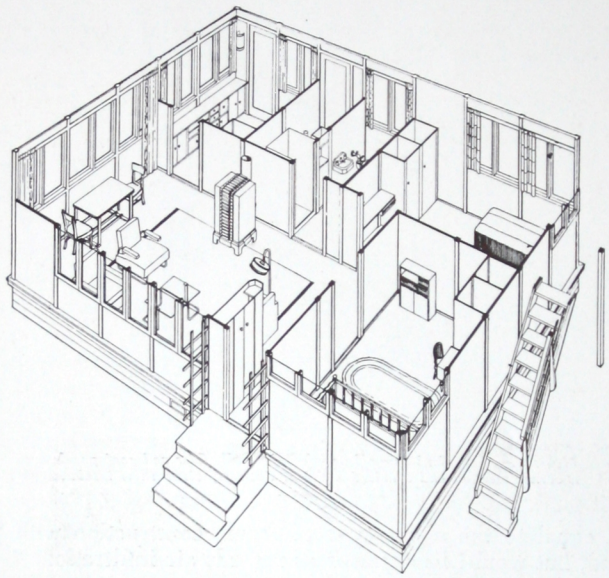


Figure 4.—Perspective drawing of completed house with roof removed, showing floor arrangement and built-in features.

For some purposes, the demonstration house might recommend itself as an investment, just as it stands, but the larger and more vital question is whether it and thousands to follow it will carry wood's fullest and most adequate contribution to the housing needs of the nation. This question deserves an early answer in the affirmative.

RESEARCH AND DEVELOPMENT NEEDS

The architectural question of variety versus monotony in appearance of large groups of the prefabricated type of house can be eliminated at the outset, since the basic idea in this development is not a unit house but a system of building units. The substitution of wall, floor and roof panels for smaller traditional integers such as bricks, boards, or slates actually insures wide flexibility in design of individual houses and admits of any size, number and arrangement of rooms desired.

A remark often heard in viewing the demonstration house is: "It's got a flat roof!" So it has, with stairs and a railing, and so have 75 percent of the houses shown on plans submitted in a recent nation-wide General Electric contest to determine the best type of modern American home. The reason is economy, efficient utilization of space, an extra opportunity for the family to take the sun and air. Nevertheless, to please all tastes and all purses, study might well be undertaken looking to the adaptation of roof units to a standard or variable pitch and to various types of prepared waterproof covering.

Similarly, the Laboratory engineers look forward to the opportunity of comparing and testing out different materials and methods of panel insulation and determining the most practical permanent treatment of interior and interior surfaces, as well as adjusting construction details to full production and service requirements. It is felt, however, that a substantial beginning has been made toward the realization of a mass-production all-wood house on a strict economy basis, with adequate provision for an American standard of comfort and convenience. Active interest of the wood industries has stimulated development of the project to this point and is counted on to see it through to a definite and favorable outcome.

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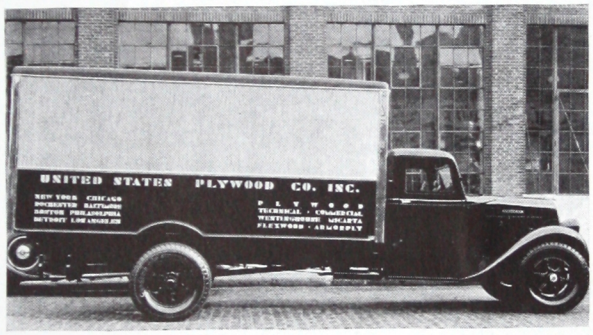

This truck has an upper panel of resin glued Weldwood with White Mahogany face and a lower panel of black Micarta with lettering of inlaid aluminum.

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